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DUAL-USE APPLICATIONS OF INFRARED SENSITIVE MATERIALS

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JUNE 1993

APPENDICES

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## Appendix A

### Current Military Programs to Develop Sensitive Infrared Detector Technologies

#### With Dual-Use Potential

As table A-1 illustrates below, there are nearly 20 DoD funded programs to either develop second generation MCT-based focal plane arrays or their components, or to integrate such sensors into operational systems. Although some programs address essential producibility issues such as PACE II and SHIELD, others are nearing initial production runs, including the Thermal Weapon Sight and AN/AAS-42. All together, total military demand for IR arrays in the 1990s could reach 300,000 units or more, resulting in a market worth about \$6 billion, at today's prices. In response to this rising demand, manufacturers have developed more than 65 types of IR focal plane arrays (see tables A-2 and A-3).

Amongst this broad range of development programs, four have particular potential to advance the potential of IR sensitive detectors for dual-use applications: Javelin missile, Thermal Weapon Sight (TWS), Standard Advanced Dewar Assembly (SADA), and the Infrared Materials Producibility Program. Each can make a unique contribution to the commercialization of IRFPAs. We describe each program below, and report the opinions of program officers, contractors, and outside commentators on its commercial potential. Most importantly, we analyze both the advantages which each program could offer in the development of detectors with dual-use potential, and the commercial limitations of each.

#### Javelin Missile Program

The US Army and Marine Corps plan to procure about 67,000 second generation FPAs for the Javelin missile program, at affordable prices. If any military program can bring down the costs of IRFPAs through economies of scale, automation, batch production, and other volume related manufacturing gains, it is the Javelin. Although the eventual cost of the IRFPAs being used in the Javelin missile is highly uncertain, most estimators believe that the total cost will exceed one-half billion dollars over the next ten years.

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Table A-1. Development Programs for Second Generation IRFPAs

Weapon System	Prime Contractor	Supplier of IRFPA	Size of Array Bandwidth	Material Used	Notes
TRUGAT anti-tank missile	SAT	EURODIR (joint venture of SOFRADIR and AEG)	288x4 LWIR (thermal sight for long range version)	MCT	To be placed in ground based launchers, Tiger/Tigre helicopter, and as aircraft's piloting aid.
"	"	EURODIR	48x4 LWIR (thermal sight for medium range version)	MCT	
"	"	EURODIR	32x1 LWIR (for seeker for long range version)	MCT	
MICA air-to-air missile	MATRA	SOFRADIR	64x1 MWIR (for seeker)	MCT	
Follow-on Early Warning System (FEWS)	Lockheed Missiles and Space	SBRC	?	MCT	
Brilliant Eyes Dem/Val	TRW	SBRC	?	MCT	
Javelin anti-tank missile	TMM	SBRC	64x64 LWIR (for seeker)	MCT	
"	"	TI	240X1 LWIR (for CLU)	MCT	

Weapon System	Prime Contractor	Supplier of IRFPA	Size of Array Bandwidth	Material Used	Notes
Second Generation Tank Sight (SGTS)	Hughes Electro-Optical Systems	SBRC	460X4 LWIR	MCT	
Thermal Weapon Sight	Hughes Electro-Optical Systems	SBRC	40x16 MWIR	MCT	TEC cooled. First second generation device to be off the blocks.
FEWS Bid	TRW/Crumma n	Loral Infrared Imaging Systems (LIRIS)		MCT	
Ground Based Interceptor	MM/Lockheed	LIRIS	480x380 PnSi CCD 128X128 (for sight) LWIR (for seeker)	MCT	
Electro-Optic Sensor System for RAH-66 Comanche	MM	LIRIS	480X4 LWIR for Electro-Optical Target Acquisition/Designation System for Night Vision Pilotage System	MCT	
Multi-Sensor Target Recognition System	MM	LIRIS	480X4 LWIR	MCT	
AdvancedIRST	MM	LIRIS	480x4 LWIR	MCT	A candidate to equip Lockheed's F-22 fighter and other aircraft under a US \$50 m contract from US Air Force's Wright Laboratory
FLIR and Automatic Cues Technology Insertion into the LANTIRN	MM	LIRIS	480x4	MCT	Under test by US Air Force, to replace the standard first-gen FLIR in the LANTIRN targeting pod with an FPA-based imager.
AN/AAS-42	MM	GE Aerospace (purchased recently by MM)	256x1	MCT	For US Navy F-14Ds. The first production application of second-generation long-wave arrays.

Weapon System	Prime Contractor	Supplier of IREPA	Size of Array Bandwidth	Material Used	Notes
FEWS bid	Grumman Space & Electronics Group	Rockwell International Electro-Optical Center	MWIR LWIR	MCT	
Helicopter Extended Range Laser Illuminating Sight	Rockwell International Tactical Systems Division and SFIM (France)	Rockwell International Electro-Optical Center (EOC)	MWIR 256x256	MCT	
SDI Miniature Seeker Technology Integration	Rockwell	?	?	MCT	
Infrared Materials Productivity Program	Johnson Matthey Electronics-led Consortium	N/A	Various	MCT	
Standard Advanced Dewar Assemblies		TI	240x4 480x4	MCT	Potentially used in Improved TOW Acquisition Sight. TI's own Combat Vehicle Tank Thermal Sight, and an upgrade to the Commander's Independent Thermal Viewer for M1A2
Silicon Hybrids with Infrared Extrinsic Long-Wavelength Detectors (SHIELD)		Rockwell EOC	128x128 256x256	Extrinsic silicon	From USAF Phillips Laboratory. Will use blocked impurity band technology developed under the HIWAYS productivity effort to provide arrays for several SIDO programs, including Brilliant Eyes and GBL

Weapon System	Prime Contractor	Supplier of IRFPA	Size of Array Bandwidth	Material Used	Notes
Producible Alternative to Cadmium Telluride for Epitaxy (PACE I)	Rockwell EOC	Rockwell EOC			Uses MCT deposited on a sapphire substrate to produce circular wafers. Rockwell says that this approach, with which it has made dramatic strides in the past year, allows it to produce the highest-quality detectors available and to achieve a yield significantly above norm
PACE II	Rockwell	Rockwell	LWIR staring and scanning	MCT on GaAs	Has not progressed as fast as had been hoped and has been returned to laboratory status for further research. The next approach to reach production is expected to be PACE III, using MCT on silicon

Table A-2. MCT-based IRFPAs for Military Applications

Company	Infrared Focal Plane Array			Known Uses
	Array Format	Bandwidth	Material	
GEC-Marconi Infrared (formerly Phillips Components)	Formats up to 1,024x1	?	MCT	Development for Marconi Radar and Control Systems, funding from UK Defense Research Agency (DRA).
"	128x128	?	MCT	"
Loral Infrared and Imaging Systems	240x1	LWIR	MCT	CLUs for Javelin second source.
"	?		MCT	For the TRW/Grumman FLEW/S candidate.
"	480x380	Visible	CCD, P-Si	Sight for the MM/Lockheed team for the Ground Based Interceptor bid.
"	128x128	LWIR	MCT	Seeker for GBI bid.
"	480x4	LWIR	MCT	For MM's Electro-Optic Sensor System (EOSS) to equip the US Army's RAH-66 Comanche helicopter. This includes two FIRs: the Electro-Optical Target Acquisition/Designation System (EOTADS) and the Night Vision Photage System (NVPS). Also for ARPA's Multi-Sensor Target Recognition System to develop technology for the autonomous attack of high-value mobile targets such as tactical ballistic missile launchers. Also for Advanced IRST under development by MM as candidate for Lockheed F-22 and other aircraft. Also for FRACITIL (FIR and Automatic Cues Technology)
Marin Mancilla (formerly GE Aerospace Electronics Laboratory)	256x1	LWIR	MCT	AN/AAs-42 IRST being supplied for US Navy F-14Ds, the first production program for LWIR IRFPAs.
"	512x1	LWIR	MCT	Prototype.
"	1,024x1	LWIR	MCT	Prototype.

Company	Infrared Focal Plane Array			Known Uses
	Array Format	Bandwidth	Material	
"	480x4 TDI	LWIR	MCT	Part of sensor suites successfully demonstrated by MM for the RAH-66 Comanche that can discriminate between targets 50-60 percent better than its predecessor on the AH-64 Apache. Two second-gen FLIRs are to work in conjunction with the Comanche's "Two Bar Scan" target acquisition system, and aid in navigation.
Hughes' Santa Barbara Research Center	?	LWIR	MCT	For Lockheed Missiles and Space Company for its FLEWS (Follow-On Early Warning System) bid.
"	?	LWIR	MCT	For TRW on Brilliant Eyes Dem/Vol Program.
"	64x64	LWIR	MCT	Seeker for TI/MM Javelin missile.
"	128x128	LWIR	MCT	Hughes Aircraft Co.'s Missile Systems Group is planning to propose use of an imaging infrared seeker on the possible successor to the Sidewinder air-to-air missile, currently known as the AIM-9X, which would use this IRFPA.
"	480x640	LWIR	MCT	Believed to be largest MCT array. Possible applications are as sensors on the future Navy AX aircraft and the next generation M-1 tank, and a number of low-cost commercial security systems.
"	480x4	LWIR	MCT	To Hughes EOS for Second Generation Tank Sight (SGTS) technical demonstrator for NVI/OD.
"	40x16 TDI	MWIR	MCT	To Hughes EOS for AN/PAS-13 Thermal Weapons Sight (TWS).
"	960x4	LWIR	MCT	Developed under DARPA's Infrared Focal Plane Array program, and recently delivered to TI for implementation in a forthcoming helicopter electro-optic system.

Company	Infrared Focal Plane Array			Known Uses
	Array Format	Bandwidth	Material	
SOIRADIR (France)	288x4	LWIR	MCT	Adopted for the British/French/German TRIGAT. Will form heart of SAT thermal sight for the long-range version of TRIGAT, both in ground-based launchers and aboard Tiger/Tigre helicopter, and will be used as an aircraft's piloting aid. Also chosen by nine manufacturers in seven countries for basis of FLIRs and IRSTs. SAGEM doing the most with them for submarine periscopes. Also purchased by Kolsman and Texas Instruments.
"	32x1	LWIR	MCT	Seeker for long-range TRIGAT. Seeker for Norwegian missile undergoing flight trials.
"	288x1	LWIR	MCT	
"	1,152x1	LWIR	MCT	
"	480x4	LWIR	MCT	
"	48x4	LWIR	MCT	Thermal sight for medium range version of TRIGAT. Also sold to TI for FLIR in Loral Vought System's LOSAT hypervelocity anti-tank weapon.
"	288x4	MWIR	MCT	
"	64x1	MWIR	MCT	Prototype. For seeker that SAT is developing for the Matra MICA air-to-air missile.
"	64x64	LWIR	MCT	Prototype.
"	128x128	MWIR	MCT	Prototype.
Texas Instruments	TDI family of 240x2 480x4 960x4		MCT	Designed to fit into SADAs. Potential applications include the Improved TOW Acquisition Sight (ITAS), TI's own Combat Vehicle Tank Thermal Sight (CVTTS), and an upgrade to the Commander's Independent Thermal Viewer (CITV) installed in the M1A2 tank. TI has bought TDI arrays from SOIRADIR as an interim measure.
"	240x1	LWIR	MCT	For CLUs for Javelin

Table A-3. Non MCT-based IRFPAs for Military Applications

Company	Infrared Focal Plane Array			Known Uses
	Array Format	Wavelength Band	Material	
Amber Engineering (A Raytheon company)	128x128	LWIR	InSb	For insertion into Amber's Series 4000 and 5000 cameras.
	512x512	LWIR	InSb	Advanced Large-area Infrared Transducer (ALIRT) program sponsored by SDIO. Builds on success with 128x128 and 256x256 arrays.
	256x256	LWIR	InSb	Put into prototype imager by Marconi Radar and Control Systems for UK Defence Research Agency for FARSIGHT demonstrator program. The imager will be installed in a high-performance aircraft to evaluate its usefulness for applications including plucking aids and detection of airborne and ground-based targets. Also for DRA's program on autonomous seekers for air-to-surface weapons. Existing array should be replaced with another Amber 512x512 later on. Marconi also considering offering a new system using the same array for retrofitting in tank sights.
Cincinnati Electronics	160x120	LWIR	InSb	
	256x256	LWIR	InSb	Prototype.
David Samoff Research Center	640x480	MWIR	PtSi	May be upgrade using indium silicide detectors manufactured under contract to the Rome Laboratory.
	?	LWIR	Germanium Silicide	In collaboration with Jet Propulsion Laboratory and Princeton University.
Eastman Kodak	640x480		PtSi	Kodak is selling its PtSi camera business to companies in Europe and the US, but is continuing with development and manufacture of the arrays themselves for their industrial camera business.
Honeywell/Alliant Techsystems		LWIR	Microbolometers	For Army's Low-Cost Uncooled Sensor Prototype (LOCUSP) program.
Hughes Technology Center	640x480		PtSi	Potential use in the NLOS-CA missile program.
Later Aeronutronic	256x256	MWIR	PtSi	For possible use in missile seekers, airborne surveillance pods, and thermal weapon sights.



Company	Infrared Focal Plane Array			Known Uses
	Array Format	Wavelength Band	Material	
Loral Fairchild Systems	640x480	MWIR	PtSi	For B-52 retrofit program to replace the standard AN/AQ-6 FLIR in the navigation and targeting system aboard the B-52G/HI planes. May also be used for Loral Thermal Sight System (LTSS), intended to replace the image-intensification elbows in M32, M35 and M36 periscopes aboard armored vehicles such as the LAV-25. Also may be in Loral Gunner's Sight (LGS).
Loral IRIS and Fairchild	?	MWIR	PtSi	Seeker to perform acquisition, tracking, and aim-point selection for the Theater High Altitude Area Defense (THAAD) missile system. System incorporates a Loral Fairchild system two-axis gimbaled camera (using PtSi array), integrated with an inertial measurement unit employing ring laser gyros.
Mitsubishi Electric	1,040x1,040	MWIR	PtSi	Uses proprietary charge-sweep device (CSD) technology which provides a greater amount of detector material in a given area than those using conventional CCD multiplexers. This array has demonstrated a 53 percent fill factor, compared with 38-50 percent for competitors' arrays. Has pixels that are 17 microns rather than usual 25 in diameter. Has licensed technology to Thomson-CSF in France.
	256x256	MWIR	PtSi	Used in M300 thermal camera.
	512x512	MWIR	PtSi	Used in IR-M500 camera.
Rockwell Electro-Optics Center	128x128 256x256	LWIR	Extrinsic Silicon	Award from USAF's Phillips Laboratory for the Silicon Hybrids with Infrared Extrinsic Long-Wavelength Detectors (SILILD) program. Will use blocked impurity band technology developed under the ITYWAYS productivity effort. For potential use in several SDIO programs, including Brilliant Eyes and GRI.
Santa Barbara Focalplane	128x128	LWIR	InSb	Put into ImagIR thermal camera system, with multiplexers supplied by partner company Westinghouse.
	320x256	LWIR	InSb	
	256x256	LWIR	InSb	

Company	Infrared Focal Plane Array			Known Uses
	Array Format	Wavelength Band	Material	
Semi-Conductor Devices (Israel)	128x1	LWIR	InSb	Company jointly owned by Tadiran and Rafael. Array for use in the seekers of air-to-air missiles and in thermal imagers. SDC has also developed LWIR MCT arrays with very smaller detector elements.
Texas Instruments			Ferroelectric	For Army's Low-Cost Uncooled Sensor Prototype (LOCUSP) program.

The Javelin is a hand-held, man-portable "fire-and-forget" anti-tank weapon intended by the Army to replace the M-47 Dragon. Each of its two main components requires a second generation focal plane array. The first, called the Command Launch Unit (CLU), is an infrared telescope weapon sight used by the operator to spot a potential target. The second component is the actual missile round. The missile cone contains an IR focal plane array which can lock on to a potential target chosen by the operator in under ten seconds, and continue to track the target until impact. During flight, the missile is connected to the CLU on the operator's shoulder by an electrical umbilical cord. As soon as the missile's IRFPA locks on to a target, however, the missile's image is transmitted back to the CLU, at which point the operator can disengage and take cover. The CLU is reusable, while the missiles are not, so the current plan is to procure twelve times more missiles than CLUs.

The Command Launch Unit and missile round each use a second generation forward looking IR detector. The CLU uses a LWIR, MCT-based, 240x1 scanning array, cryocooled to 77°C. The CLU scans an image bi-directionally, with 120 pixels reading in one direction while the other 120 scan in the opposite direction. The unit operates at a rate of 30 Hz, and produces a 240x480 display. Although the image is viewed through an eyepiece, it also can be read out digitally to other display units or video equipment through a port on the unit's side.

The IR detector in the CLU operates in the LWIR for two reasons. First, the high energy of photons in the 8-12 micron window make detection easier at longer distances. In fact, any detector with ranges greater than about a kilometer needs to operate generally in the LWIR to achieve the sensitivity necessary to image objects at those distances.<sup>1</sup> Second, the LWIR is not attenuated or filtered as much as the MWIR by moisture, fog, dirt, or rain. Any ground-based IR system intended to operate under battlefield conditions can make better use of the LWIR than the MWIR.<sup>2</sup>

Texas Instruments is the primary source of the CLU scanning array. TI's novel architecture makes use of the company's Vertically Integrated Photodiode (VIP) approach. The sensor incorporates a front-side illuminated n-on-p doped MCT wafer which is essentially glued on to a silicon read-out circuit. TI claims the VIP technique can be cheaper than conventional IR detectors which are indium bump-bonded. But TI only turned to the VIP technique after failing the manufacture cheaper and better IR arrays by another innovative technique called

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<sup>1</sup> Programs to develop space based infrared sensors have used doped silicon as the excitor material, to achieve even longer-wave detection, up to about 100 microns.

<sup>2</sup> The Navy, by contrast, has preferred infrared sensors which operate generally in the MWIR because they are said to perform better in maritime environments. This is discussed further below.

## Appendix B

### Uncooled Pyroelectric Detectors Are a Formidable Competing Technology

Uncooled infrared detectors, also called pyroelectric detectors, differ fundamentally from advanced infrared detectors based on MCT, InSb, or PtSi. Uncooled focal planes are two-dimensional arrays of infrared pixels that are thermally isolated from their surroundings by insulating material. Rather than detecting photons directly, as MCT-, InSb- and PtSi- based systems do, uncooled detectors respond to incoming radiation by changing their temperature. Read-outs of signals from up to 80,000 pixels are then multiplexed and sent for processing, just as in sensitive, cooled IR detectors.

Two-dimensional staring arrays of uncooled infrared materials, such as barium strontium titanate (BST) and silicon-based microbolometers, operate at room temperature, in the long-wave infrared (LWIR) at 8-12 microns. They require no more than a single-stage, low-power thermoelectric cooler to smooth temperature fluctuations in surrounding ambient air. By comparison, the MCT-based IR system with the least cooling requirement is the MWIR staring array being developed for the Thermal Weapon Sight (TWS), which requires six-stage

thermoelectric cooling.

Texas Instruments and Honeywell are the leading developers of pyroelectric devices.

Texas Instrument's approach uses ferroelectric, BST-based arrays. The detectors are fabricated from a ceramic material, barium strontium titanate. The polarization and dielectric constant of BST pixels change with temperature, resulting in a change in charge on a capacitor as the target scene varies. The pixels are diced by the same process as MCT-based arrays. The read-out circuit chip is hybridized onto the read-out chip, just as with MCT-based arrays, using indium bump bonds. The detector looks alternately at the target scene and a background reference temperature to sense change. The incoming infrared scene is AC-coupled by a rotating mechanical chopper. Without a chopper in the system, the surface charge would dissipate and cause the scene contrast to decrease to zero, resulting in fade-out of the scene, except for any moving objects. Rows and columns of the array are read out in sequence by sending voltages along a two-dimensional switch matrix. The signals are then sent through an amplifier, a multiplexer, and an analog/digital converter prior to further signal processing. Gain and offset correction are applied to remove the fixed-pattern noise due to the non-uniformity of response of up to 80,000 detectors. Dead pixels are corrected by substituting information from adjacent pixels.

By comparison, Honeywell's approach uses two-dimensional arrays of bolometers. The

resistance of each pixel changes about two percent per degree change in temperature. Vanadium Oxide is the temperature-sensitive resistor material, suspended on a bridge of silicon nitride that is thermally isolated from the substrate containing the read-out electronics. As with TI's BST-based arrays, Honeywell's bolometers use a single-stage thermoelectric cooler. As a voltage is applied to each row of gates in sequence, a bias current flows through all of the detectors in the row, and they are read out in parallel via the column leads to a high-speed multiplexer at the base of the columns. This row of information is then multiplexed before the next row is read. Since there is no AC coupling of the incoming thermal radiation, no mechanical chopper is used. The only moving part is a shutter that is periodically closed momentarily for the system to recalibrate. As with BST-based arrays, the signals are conditioned with gain- and offset-correction to remove non-uniformities, and dead-cell correction is applied.

#### Military Development of Uncooled Detector Technology

US Army and DARPA funds helped develop pyroelectric detector technology to the point where commercial spin-offs are within grasp. Specifically, the Night Vision and Electro-Optics Directorate (NVEOD) and Balanced Technology Initiative (BTI) division of DARPA have funded basic research in uncooled infrared detectors mostly for night vision systems, and helped TI and Honeywell move a long way toward commercializing their pyroelectric technologies. TI, in particular, is venturing into commercial applications for its BST-

based system as defense funding for BST declines. It is aggressively developing a high volume production facility, fielding prototypes, and developing close relationships with potential end-users. TI executives reason that, at worst, the commercial market will tide their BST-based detector line over until other military programs using BST-based detectors come on-line. At best, Texas Instruments expects large sales in the commercial sector within the next decade.

Four military programs fostered uncooled detector technology over the last 15 years. TI began to develop BST-detector technology in the mid-1970s, whereas Honeywell only began to develop resistance bolometers in 1985.

The Short Range Thermal Sight (SRTS) was the first military system to use BST-based detectors, and demonstrated the potential of BST-based detectors for moderately demanding applications. Texas Instruments' rough prototypes integrated a two-dimensional, 100 X 100 pixel array. Although the mosaic array offered good sensitivity, the resolution was extremely poor, and each pixel measured four millimeters square, much larger than competing infrared systems.

The Army then followed-up with the Small Pixel Program (SPP), also awarded to Texas Instruments. That program doubled the resolution of the BST arrays to 100 X 200 pixels, and halved the pixel size to two square millimeters. Resolution therefore doubled while the array remained on a chip of the same size as the SRT. This demonstrated that BST-based arrays were on the road to reaching the staring potential of more expensive and more sensitive infrared

materials. From this program forward, military development efforts stressed two goals for BST-based detectors: To increase the pixel density to approach television resolution and smaller pixel sizes so entire chips could be less than one inch square.

A third Army and BTI/DARPA funded technology development program, the High Density Array Development (HIDAD), is the major reason for the current capabilities of both BST- and microbolometer-based detectors. The program was active from 1987-91, with awards to both Texas Instruments for BST technology and to Honeywell for its bolometer arrays. The goal was to procure "breadboards," table-top assemblies with accompanying racks and power supplies, designed to demonstrate the technology rather than produce fieldable prototypes. The BST-based array grew to 240 X 328, which met the goal of TV-compatible RS-170 video output. Sensitivity on those units reached about 0.2°C, from 0.3°C at the start of the HIDAD program. This is still far from the .02°C sensitivity of advanced MCT-based systems, but is acceptable in less demanding military applications and sufficient for many commercial applications. Honeywell's bolometer technology, however, did not fare as well and produced brassboards which never performed to spec and were unreliable. Honeywell took until December 1989 to demonstrate a reliable brassboard with a 240 X 336 array for HIDAD.

The most recent program to foster BST-based detector research is the Low Cost Uncooled Sensor Prototypes (LOCUSP), which is a two-phase program to deliver fieldable prototypes of four different systems for a variety of military applications. These prototypes incorporating the



uncooled HIDAD arrays described above, would meet varying performance specifications. Texas Instruments and Alliant Techsystems (with Honeywell as a subcontractor to provide microbolometer arrays) were awarded contracts for BST- and bolometer-based technologies.

Phase I of LOCUSP, which ended in early 1993, developed a medium-range thermal imaging weapon sight and a thermal sensor for surveillance applications. TI manufactured 23 fieldable prototypes for that phase. They included six for the Air Force for security surveillance of airstrips containing the B-2 Bomber, one to the Naval Research Lab for reconfiguration into a fire fighter's helmet for vision through smoke, and six to the Immigration and Naturalization Service (INS) as a surveillance aid atop police vans. TI was able to increase the average sensitivity to  $.08^{\circ}\text{C}$ , with a distinction of  $.065^{\circ}\text{C}$  possible at a higher cost. The systems cost \$100,000 each to manufacture, which of course is far more than they would cost in volume production. Alliant Techsystems, however, has not yet developed a working prototype that achieves all the milestones. Most officials we contacted attributed this to Alliant/Honeywell's late entry into the uncooled market. Their technology is still immature, and will take two to three years to catch up to Texas Instruments'.

Phase Two of the LOCUSP program would procure fieldable prototypes of sub-munition seekers and missile seekers, and require detectors which meet more stringent parameters. Sensitivity would need to be better than  $0.1^{\circ}\text{C}$ . The sub-munition environment would challenge system design because of the jolt and stress on electronics during launch from a howitzer.

Although both contractors met the performance requirement of 0.1°C, which was the required NETD (sensitivity) for the modified HIDAD program, funding cut-backs have prevented NVEOD from authorizing the contractors to begin Phase II of the LOCUSP program. The hold-up appears to be more due to realignments within DARPA itself as it takes the BTI office under its fold than wholesale loss of interest in uncooled technology.

Representatives from the Army, Marines, Air Force, Navy, INS, Sandia National Laboratories, and other government agencies have been following progress on the LOCUSP program closely, because system prototypes have many potential applications outside of submunitions and surveillance cameras. The Air Force and Navy, in particular, were not part of the original review sessions but have joined and purchased prototypes because of their interest in LOCUSP. The small size, light weight, low power requirement, and availability of video output from the weapon sight of Phase I prototypes make them particularly useful for portable applications, and for commercial spin-offs.

The development of uncooled detector technologies has not been funded by Army and DARPA decision-makers since fiscal year 1991, however, and these technologies are beginning to lose their footing in the infrared market. According to industry and military officials, the next logical step in development would be a program to design a monolithic architecture for the BST-based detector. The Army's Thermal Weapon Sight (TWS) program, for example, could have further honed BST-detector technology, but performance requirements all but ruled out uncooled

technology. For example, the TWS program intends to acquire at low cost about 20,000 rifle sights operating in three standard ranges: 550 meters, 1,100 meters, and 2,000 meters. BST-based detectors could currently meet the short and medium, but not the longest range requirement for the TWS. BST-based systems also require about one watt more of electricity, and weigh about a half pound more, than is specified for the TWS. For these reasons, Texas Instruments was not awarded a TWS development contract, losing out to Santa Barbara Research Center (SBRC) for MCT-based detectors using thermo-electric coolers (TECs).

#### Advantages and Disadvantages of Uncooled IR Detectors

Uncooled detectors offer substantial advantages which make them attractive in night vision equipment, thermal weapon sights, sub-munitions and missile seekers, and surveillance equipment, and also give them strong commercial potential. Most importantly, the absence of a cryocooler and dewar saves up to \$10,000 per unit. Uncooled detectors also have very modest power needs at about three watts, and can run for long periods without recharge, about 24 hours with standard military batteries. Since they do not need frequent topping off with liquid nitrogen, uncooled detectors are more portable, as well. Even a closed-cycle cryocooler needs to have its hydrogen recharged every 800 hours, reducing portability. Uncooled staring detectors also do not have the optics used in scanning infrared detectors, and are therefore an additional several thousand dollars cheaper and easier to maintain. They have virtually no moving parts, which

increases reliability, reduces maintenance, and system costs. TI's BST-based detectors have one moving part, which is a simple mechanical chopper. Honeywell's bolometers have no moving parts at all.

These advantages of uncooled infrared detectors are tempered by several disadvantages.

- The largest drawback is that uncooled detectors are an order of magnitude weaker than MCT- or InSb- based systems in resolution, fill factor, and quantum efficiency. Pyroelectric materials offer only moderate performance, a weakness inherent in their physical properties.
- Second, TI's BST-based detectors in particular have a degree of signal crossover which causes bright spots in an image to spill over into adjoining pixels. This is inherent in BST-based detector architecture, and can not be overcome. TI's detectors use diced and thermally isolated BST cubes, covered by a silicon signal processor which is both a ground for the common electrodes and a thermal pass. As a result, though, electrons leak to read-outs from neighboring pixels, producing an image which is less crisp. This problem is not found in Honeywell's bolometers, which have a bridge structure that supports the sensor and is thermally well isolated from adjacent detectors, preventing any thermal cross-talk.
- Third, uncooled detector arrays cannot measure absolute temperatures in each pixel of view because they do not have advanced gain and offset correction as MCT-based systems do.

However, advocates of pyroelectric detectors note that uncooled detectors could make absolute temperature measurements if simple signal conditioning technologies were developed (or adapted from MCT-based detector technology). That capacity has not been developed in the past because thermal weapon sights and night vision equipment, the devices for which uncooled detectors were developed, do not require radiometric measurements.

In summary, uncooled IR detectors offer cost advantages that are offset by performance drawbacks. The potential markets for pyroelectric detectors, therefore, are applications for which neither sensitivity nor absolute temperature measurement are paramount issues. These areas of application require infrared detectors which are easy to maintain, operate at moderate scan rates (about 30 Hz), maintain sensitivities of about  $0.1^{\circ}\text{C}$ , and do not require radiometric readings. If uncooled IR detectors can be manufactured for less than \$3,000, as producers claim can be achieved, they could likely overtake competing IR materials for such less sophisticated applications as non-destructive evaluation of buildings and structures, food inspection, underground remote sensing, pipeline and gas leak detection, driver's vision enhancers, and IVHS components.

#### Texas Instruments Considers Commercialization

Officials at Texas Instruments state that BST-based detectors now meet two criteria for entry into the commercial detector market:  $0.1^{\circ}\text{C}$  sensitivity, and resolution fine enough for a

television screen. Both standards had been met by detectors manufactured for the HIDAD program, and refined for Phase I of the LOCUSP program. Texas Instruments has turned its efforts, therefore, toward meeting a final criterion for entry into the commercial market: drastic cost reductions.

TI fabricated BST-based detectors in a laboratory-style environment for the HIDAD program. Production was in low volume with a high fraction of the cost attributable to manual labor. BST wafer yields were as low as five percent for the early HIDAD detectors. TI's first priority, therefore, was to construct a new facility which integrated automated processes in a high volume production line. That facility is still being put together, having cost \$10 million over the last two years and still in need of \$5 million to \$10 million over the next year before completion. The center has been designed to produce 1,000 uncooled detector units a month.

TI took several innovative steps to design this facility to produce cheap BST-based IR detectors for the commercial market. The facility was designed to be about ten times cleaner than TI's other infrared production facilities, because impurities are a leading problem in bringing up the yields of BST-based arrays. A statistical process control system has also been set up to increase yields. Also, although the silicon wafer industry has advanced to about 8-inch square wafers, TI utilizes in its new facility some older, silicon processing equipment which makes cheaper 4-inch square wafers. Those wafers are used for signal processing and hybridized with the BST wafers to make the detector. That silicon processing equipment had become obsolete

to TI's integrated circuit board business, but produces wafers which are cheaper and satisfactory for hybridization with BST wafers bound for the commercial market. Without the need to make silicon wafers for hybridization to military specs, one executive at TI estimates that the new boards could be made at one-hundredth their military cost. Slice processing also reduces recurring labor cost, because forty to fifty detectors are processed simultaneously, instead of one-by-one.

TI has embarked on a sophisticated marketing effort for its BST-based system. Early-on, the company decided to focus on four prospective commercial market segments: surveillance, all-weather and night vehicle vision, predictive maintenance, and remote sensing. About ten people at TI work full-time researching these potential segments, talking with prospective customers, taking market surveys, and discussing needs with prospective end-users. This market-oriented approach is much different from the classical technology-directed commercial attempts being made by several other US military contractors. Test units have been sent out to users in key industries, and feedback is sought on how well the BST-based pilot installations meet customer needs. For instance, a TI uncooled specialist explained that the commercial trucking business could use infrared detectors to aid in night vision and collision avoidance. When a trucking company executive saw TI's prototype unit, according to an official at TI, he suggested they create a model to test the brake pads of trucks. Truck drivers are sued for millions of dollars each year for accidents caused by brakes which overheat and fail, and there are no quick and reliable non-destructive testing techniques short of dismantling brakes. So TI is now developing

a thermal vision system to meet that application also. By working closely with end-users, TI is developing systems which meet customer needs and helping design altogether new applications. No one else in the military infrared business appears to have tried these pilot installations, or solicited so much feedback from prospective customers.

Executives at TI claim that BST-based detectors will fall in price to about \$5,000 each when their facility begins operation in 1994, and that many commercial applications can be met at that price. The eventual goal is to reach about \$500 a unit, which would enable very large scale production in the tens of thousands of units per year. The foremost high-volume application which TI is reportedly seeking is placement of BST-based detector in cars as a night-vision aid. Development of the truck prototypes is expected to help reach economies of scale. There are reports from executives outside of TI that BST-based arrays will be purchased in great numbers by Hughes and General Motors for placement in Cadillac-model cars as early as 1995, but more likely by 1997. Amid industry reports that both the Japanese car manufacturers and BMW are interested in placing similar head-up displays in their cars after 1995, the transportation market could be extremely profitable. Placement of BST-based detectors in the Cadillac would certainly be a breakthrough for TI and the commercial infrared market. Hughes is widely acknowledged by outsiders as the unspecified "large defense contractor" with which TI is teamed in the BST-detector business, but executives at TI have not gone public with the name of its teaming partner.



Executives at TI stressed that their extensive development of BST for the commercial market will feed back positively into their ability to compete in the military infrared market as well. If the Army and DARPA have confidence in TI's extensive BST-based detector experience, according to TI executives, they will be more likely to give the go-ahead for Phase II of LOCUSP and design all together new programs around BST-based detectors. They even contend that TI will be able to compete for lower-end infrared applications which could use MCT, PtSi, and InSb-based detectors in three particular military programs.

First, the Driver's Vision Enhancer (DVE) program plans to procure 19,225 infrared detector units beginning in 1998 for Army wheeled vehicles. Operation Desert Storm highlighted the need for night vision equipment on all Army vehicles; tanks outfitted with night vision equipment advanced during the night but had to leave support vehicles behind with supplies, equipment, and food. BST-based detectors could reportedly meet the DVE's specifications, but would have to compete directly with more sensitive and more expensive cooled detectors. A request for procurement is expected to be released during the first half of 1993.

Second, DARPA's Flexible Manufacturing Program may have about ten percent of its funds fenced off for uncooled detector technology, but TI executives believe they could meet the specs for cooled IR detectors as well. Third, TI believes it could be an attractive recipient for DARPA's dual-use funds because it is cultivating a technology with clear military and civilian uses.

In summary, Texas Instruments is keeping its BST-based detector unit in "fighting shape" for military programs which may potentially use ferroelectric detectors. Without its sustaining commercial effort, TI contends that its BST production facilities and expertise would be idle. The synergies between Defense and commercial applications are apparent.

## Appendix C

### Annotated Bibliography Database

#### (i) **Basic Scientific Primers**

Arams, F.R., Infrared to Millimeter Wavelength Detectors (New York: Artech House, 1973). A collection of reprints.

Cenn, G.K.T. and D.G. Avery, Infrared Radiation (Boston: Van Nostrand, 1966)

Dereniak, E.L. and D. Crowe, Optical Radiation Detectors (New York: Wiley, 1984)

Ghys, R., Thermaographic Medicales (NY:Somabec Ltcc, 1973).  
On the clinical aspects of infrared thermography.

Hadni, A., L'Infrarouge lointain (Paris: Presses Universitaires de France, 1969).

Holter, M.R., S. Nudelman, G.H. Suits, W.L. Wolfe and G.J. Zissos, Fundamentals of Infrared Technology (New York: Macmillan, 1962).

Hudson, R.D., Infrared System Engineering (New York: Wiley, 1969).  
Probably the best of the group for a general introduction. It comes from a collection of design experience at Hughes. It has been around for a while, as is evident by the date, but the fundamentals do not change. It is also distinguished by a very fine literature search, including much material that appeared in patents. The last part has a nice collection of discussions of various infrared applications.

Hudson, R.D. and J.W. Hudson, Infrared Detectors (New York: Dowden, Hutchinson and Ross, 1975).  
A collection of reprints.

Jamieson, J.A., R.H. McFee, G.N. Plass, R.H. Grube and R.G. Richards, Infrared Physics and Engineering (New York: McGraw-Hill, 1963).  
This was a very early book in the field. It is similar to Kruse and Seyrafi, with a slightly different emphasis. Jamieson is strong on statistics and detection theory.

Johnson, R.B. and W.L. Wolfe, Selected Papers on Infrared Design (Bellingham, WA: SPIE, 1985).  
A two-volume collection of papers devoted to various aspects of infrared design.

Kemp, B., Infrared (City: Sams, year unknown)

Keyes, R.J. Optical and Infrared Detectors, Topics in Applied Physics (New York: Springer Verlag, 1980).  
A collection of chapters, written by authorities, just like the two Willardson books.

Kingston, R., Detection of Optical and Infrared Radiation (Springer Verlag, 1978).  
A well organized and minimalist book (read: short and small) which leaves much of the derivation development to the reader. It is a good book for those who are already technically prepared.

- Kroger, F.A. The Chemistry of Imperfect Crystals, 2nd rev. ed. (Elsevier, New York, 1974).  
A classic on semiconductor crystal growth which explains techniques, types of defects, and epitaxial growth. "Essential reading" on crystal science.
- Kruse, P.W., L.D. McGlauchlin and R.B. McQuistan, Elements of Infrared Technology (New York: John Wiley and Sons, 1962).  
Best of the older books on detectors, and the "purple peril" is the best introduction
- Lloyd, J.M. Thermal Imaging Systems (New York: Plenum Press, 1975).  
The best of the lot on the design of thermal imaging devices, and comes from the collected wisdom of Honeywell and the Night Vision Lab. It includes excellent discussions of the use of modulation transfer functions, when they were still new to the infrared field. It is also a fine treatise on the properties of the eye as it relates to the sensitivity of real-time infrared systems.
- Morton, F.D., T.J. Jarratt, P.R.D. Coleby, R.A. Lockett, M.H. Jervis, R.J. Hutchinson, Applications of Infrared Detectors (City: Mullard, 1971).
- Rhines, F.N., Phase Diagrams in Metallurgy: Their Development and Application (McGraw Hill, New York, 1956)  
A classic on wafer and epitaxial growth which explains the fundamentals on MCT and semiconductors which still apply today.
- Scyrifi, K., Electro-optical Systems Analysis (Electro-Optical Research Company, Phoenixville, PA, 1973).  
Although published by his own company (and therefore not receiving the benefit of outside review), a thorough treatment of the details of system design in the visible and the infrared.
- Simon, I., Infrared Radiation (New York: Van Nostrand, 1966)
- Spiro, I.J. and M. Schlessinger, Infrared Technology Fundamentals (Toronto: Marcel Dekker, 1989)  
The newest addition to the seminal pieces; the authors have spent much time at Aerospace. It has a spacey flavor, and it incorporates modern considerations of staring systems.
- Vanzetti, I., Practical Applications of Infrared Techniques (New York: Wiley, 1972).  
as good insights into present (in 1972) and future applications for infrared technology at the back of the book in which it lists and discusses applications.
- Wallace, J.D. and C.M. Cade, Clinical Thermography (Boston: CRC Press, 1975).  
Largely on the medical use of thermal imaging, which is a burgeoning field using infrared scanners.
- Willardson, R and R. Beer, Semiconductors and Semimetals Volume 5 (1970) and Volume 12 (1977), Infrared Detectors (New York: Academic Press, 1970).  
Detailed treatments of the physical properties of detector materials.
- Wolfe, W.L. and G.J. Zissis, The Infrared Handbook (Ann Arbor, MI: Environmental Research Center, 1985).  
Not meant to be tutorial, but has much data. Will serve as a dependable reference piece.

## (ii) Overviews of Technological Trends

Ballingall, R.A. "Review of Infrared Focal Plane Arrays," (SPIE Paper 1320-11) 1990.

General technological discussion and introduction into varieties of arrays, technologies and concepts.

Balcerak, Raymond and Lynette Brown, "Mercury Cadmium Telluride Material Requirements for Infrared Systems," J. Vac. Sci. Technol. B (Jul/Aug 1992), 1353-1358.

Discusses primarily how the choice of infrared detecting material in second generation photovoltaic IRFPAs and its quality affect nearly all the other design requirements in an IRFPA, from signal processing, to cooling requirements, to processing electronics. It stresses that by boosting uniformity, reliability, and size of wafers, primarily MCT, will cut the overall system cost. There is a discussion of ways to improve on MCT epitaxial quality.

Botts, S.E., "New Horizons for IR FPA," Photonics Spectra (July 1988), pp. 125-28.

A bit dated, but explains that infrared systems utilize light-sensitive devices for the conversion of thermally generated photons into electronic signals that are amplified and processed to perform a variety of functions including targeting, tracking and imaging. As the technology matures, so do the integrated circuits that read out the infrared signals from the detectors and the parallel processors that operate on the signals. This article is an overview of second-generation detectors, integrated readout circuits, focal plane configurations and parallel processing.

Cross, E.F., and T. Reese, "Figures of Merit to Characterize Integrating Image Sensors: A Ten-Year Update," (DTIC: Sept 1989), 34p.

A ten-year update is presented on performance criteria and measurement techniques to evaluate integrating image sensors. The integrating image continuously monitors the field of view and an electronic mechanism that sequentially reads out the integrated signal on each resolution element. Ten years ago, camera tubes were the integrating imager of interest; today, staring focal plane arrays have supplanted camera tubes as integrating imagers. The adaptability of the 1978 figures of merit to the new staring devices is reviewed and, when indicated, modified.

Director of Defense Research and Engineering, DoD Key Technologies Plan, (Department of Defense, Washington: DC) July 1992.

A yearly document on key technologies which DoD considers critical to the national defense. Printed to fulfill the requirement of the National Defense Authorization Act of FY 1990 and 1991.

Extensive discussion of passive sensors, trends, technologies, producers.

Elliot, C.T., "Future Infrared Detector Technologies," Fourth International Conference on Advanced IR Detectors and Systems (London June 5-7 1990), pp. 61-68.

Trends in infrared detectors are toward larger, electronically addressed arrays and higher operating temperatures. This will lead both to higher performance and to smaller, lighter, more affordable systems. Three detector technologies are discussed: electronically addressed thermal detector arrays, Schottky barrier devices, and CMT FPAs. IR detectors based on low dimensional solids are considered briefly.

Gillham, J.P., "Materials and Technology Research in Uncooled Ferroelectric IR Detector Arrays," Fourth International Conference on Advanced IR Detectors and Systems (London June 5-7 1990), pp. 69-

77.

A technical piece on the key areas of technological advancement in ferroelectric IRFPAs which may render them very useful in industrial applications. The emphasis is decidedly on technical research rather than applications. This is a good piece on emerging IRFPA materials.

Hartung, C., Mueller, J. "Sensitive Detection of Infrared Radiation, the Optothermal Detector and its Application," Infrared Physics (May 1989), pp. 279-284.

The development of thermal detectors has reached a high technological level. The main characteristics such as detectivity, sensitivity and noise equivalent power are near the theoretical limits. The way to future development of detectors will be their specialization, especially their combination with other physical effects. Recent developments of room temperature infrared detectors, especially considering the coupling of the detectors with absorption in gaseous media, i.e. optothermal detection, is discussed.

Hoelter, Ted. "Testing Second- Generation IR Focal Planes," Photonics Spectra (July 1992), pp. 105-108.

Modern 128X128 and 256X256 FPAs are constructed by indium-bump-bonding a Si readout device to the InSb detector array. Testing must be done on both the individual components and the completed, bonded device. McCoy, Joseph R., "FPA Packaging: A Second Generation," Photonics Spectra (January 1992), pp. 99-100.

The second generation of FPAs, called integrated detector/cooler assemblies, offers higher performance, less weight, and less expensive infrared systems for sale on both the military and commercial markets. Improvements were made possible by databanks on expansion of key materials under varying temperature, as well as analyses of predicted stress areas on the FPAs. Although the U.S. military is committed to an effort to make this second generation of FPAs commercially available and standardized, several key parameters vary on the market, making standardization difficult.

Jamison, J.A., "Infrared Technology: Advances 1975-1984," (SPIE Vol. 510, 1984) pp. 56-68.

Extremely informative historical piece on the major technological issues which were overcome in that period! Jamieson is a strong believer in the ability of MCT to overcome producibility issues which have plagued it since the PC scanning arrays first entered into R&D.

Leech, D.P., et. al., "Industrial Base Analysis of Infrared Detector Industry," Air Force Task Command February 1991.

Systematic analysis of every facet of the military IRFPA market, with an accent on MCT-based IRFPAs. Including market structure, market size, production techniques, materials issues, and areas where technology is still in need of research.

Leech, D.P., "The US Infrared Detector Industry: Prospects for Commercial Diversification," (SPIE Vol. 1683, 1992) 11pgs.

Industry appears to be groping to identify solid commercial applications for its more advanced technologies. Government representatives are no doubt anxious about potential erosion of the industrial base. The author suggests that some serious thought be given to innovative intra-industry or government-industry activities focused on lowering cost and providing useful information about dual-use applications.

Marchec, P.P., "New Generation Infrared Camera," (SPIE Paper 1320-18) 1990.

Work done at Thomson-TRT Defense, France on advanced IRFPA based cameras. Discussion of applications and novel technologies used to produce the camera.

Mundie, L.G. and K. J. Hofmayer, Infrared Focal Plane Array Cost Considerations in the SDI Environment (Rand National Defense Institute, August 1990), 52 pgs.

Begins with a brief background on focal-plane theory and manufacturing technology which may be very useful. It then proposes a new manner of evolving cost-estimating relationships for IRFPAs. Cost estimates have hitherto been a large problem due to the uncertainty of many cost factors (especially the array and dewar cooler)

Silverman, Jerry, et al., "Infrared Video Cameras," Scientific American (March 1992), pp. 78-83.

This is the renaissance man's introduction to IR cameras. Similar to home video cameras, these devices can "see" thermal radiation. This emerging technology offers a host of applications, including night vision, visualization of heat flow and medical analysis. There is a discussion of architecture and applications which is at the common-man's level, but little on the materials aspect.

Scribner, Dean A. et al., "Infrared Focal Plane Array Technology," Proceedings of the IEEE (January 1991), pp. 66-85.

In 20 pages, the authors give a detailed discussion, from the layman's to arch-technical level, of all major design considerations in IRFPAs. Requirements for IRFPAs are discussed and an overview is given of different IRFPA architectures. Applications are hardly discussed.

Stahl, K.J., "IR- Detectors: State-of-the-Art, Future Trends," Photonics Spectra (September 1989), pp. 95-98.

Infrared detectors are key components for systems that are used for such things as radiometry, guidance, thermal imaging, telemetry, and communication. Starting with WWII, developments were concentrated on detectors for military applications, e.g. weapon guidance, reconnaissance and thermal imaging devices. In the past ten years, however, IR detectors have become more and more important in earth-bound, air and spaceborn systems for spectral earth mapping, environmental contamination control, meteorology, volcanism study, agricultural research, resources exploration, planetary and space research and star mapping. For military applications, the spectral band from 0.9 to 14 microns is sufficient, whereas for the other mentioned applications the spectrum between 0.9 and 300 microns (and beyond) is of interest. Detecting mechanisms and future trends are considered.

Tobo, Albert, "Infrared Imaging: Detector Arrays," OE Reports (May 1992), pp. 1,13.

This is a short survey article on what technological advances are emerging in second generation IRFPAs. It discusses new architectures, matrices, materials, and the leading companies. It does not discuss applications.

Tennant, William, et. al, "Key Issues in HgCdTe- Based Focal Plane Arrays: An Industry Perspective," Unpublished Paper, 27pgs.

Technological limits rather than fundamental issues are the only barrier keeping MCT from completely dominating almost all IR applications. The paper highlights some of the more vexing and as yet unsolved. A thorough review of MCT's advantages, product source purity, lattice mismatch due to nonuniformity, MIS devices, alternative substrates, nucleation, thermal expansion differential mismatch, longevity, comparisons of different production techniques, etc. The theme is that several problems once considered limited, have either been dismissed because the problem was circumnavigated, or hitherto unimportant obstacles have become major sticking points (ie. purity) MCT materials science and engineering problems that the authors see as being important.

Wanstall, Brian and Doug Richardson, "Towards Lower-Cost Focal Plane Arrays," Interavia Aerospace Review (November 1989), pp. 1123-1126.

A thorough, albeit dated, article on the factors contributing to the expense of FPAs and research being conducted to overcome those hurdles to lowering cost. It talks about IRFPAs for military use, but the concern is cutting cost, which applies to any IRFPAs. Discusses the different military powerhouses' ideas on what IR wavelength to use, which material and substrate, and architecture.

### (iii) Trends in IR Materials

Ackerman, Robert K., "Quantum Well Designs Shed Light on Infrared Sensors," Signal (January 1992), pp. 55-58.

An extremely important article which discusses the advantages GaAs detectors built by quantum well techniques have over conventional, MCT ones. Quantum well design incorporates a detector on the surface of a microchip, decreasing size and weight while raising efficiency. A molecular beam epitaxy technique is used to deposit materials on the surface of the GaAs virtually one atom at a time to yield extremely thin, sensitive, and uniform detector layers. The tradeoff in quantum well GaAs technology is between uniformity (quantum well's strength) and sensitivity (which is MCT's strength). The technology is fairly mature and will soon be available at prices competitive with, if not cheaper than, MCT arrays.

Ashley, Steven, "New Life for Solar: Photovoltaic Power Systems," Popular Science (May 1989), p. 117.

Reports on how a hybrid solar cell of one layer of gallium-arsenide and one crystalline-silicon has reached a thirty-one-percent efficiency level.

Bailey, Robert B., et. al., "256 X 256 Hybrid HgCdTe Infrared Focal Plane Arrays," IEEE Transactions on Electron Devices (May 1991), pp. 1104-1109.

Hybrid 256 X 256 MCT IRFPAs have been developed using either sapphire or silicon for the detector substrate to meet the sensitivity, resolution, and field-of-view requirements of high- performance medium-wavelength infrared imaging systems. The special substrate eliminates the thermal expansion mismatch to the silicon readout circuit which had been a major cost factor due to cracked rejections. This may be considered a major breakthrough.

Beck, W.A. and G.D. Davis, "Overlayer Growth on HgCdTe," Journal of Vacuum Science and Technology A (May-June 1988), 9p.

The interactions between both cleaved and ion-sputtered MCT and deposited overlays are reviewed. The overlayers are classified into four groups: ultrareactive, reactive, intermediate reactive, and unreactive-based on the relative heats of formation of the overlayer telluride and HgTe and CdTe. Ultrareactive overlayers react with both HgTe and CdTe to form an interfacial metallic telluride and elemental Hg and Cd (which are lost from the interface), while reactive overlayers react only with HgTe components. Once the HgTe is depleted from the surface region, further deposition results in growth of a metallic film. Unreactive metals, on the other hand, do not react with the surface, but form a stoichiometric interface. Finally, the extent of interactions between intermediate overlayers and MCT depend on other factors, substrate material, the heat of cation alloying and the propensity of the overlayer element to diffuse into MCT.

Bicknell-Tassius, "Growth of CdTe- CdMnTe heterostructures by Molecular Beam Epitaxy," (SPIE paper 1484-02) 1991.

Brau, Maurice J. "Ultra-high-Purity Starting Materials for Infrared Detector Crystal Growth," Colorado Research Lab, December 1991, 38p.

Bubulac, L.O. "Ion Implantation and Diffusion for Electrical Junction Formation in MCT," (SPIE Paper 1848-10). Description of work going on at Rockwell Science Ctr in this area.

Cabanski, W.A. "Electronic and Optical Properties of Silicide/ Silicon IR Detectors," (SPIE Paper 1848-12). Description of work at the university of Erlangen in Germany on silicon/ silicide arrays.

Childs, A. et. al. "Manufacturing Technology for Mid-Wavelength HgCdTe," Rockwell International Electrical Optical Center, May 1991, 317p.  
Final Report



Chow, K., et. al., "Source-Coupled HgCdTe Staring Hybrid Focal Planes for Tactical Applications," SPIE (Vol. 267 1981) 6p.

Staring infrared IRFPA with epitaxial MCT epitaxial MCT photovoltaic detectors coupled to surface channel CCD multiplexers have been fabricated and characterized. A source-coupled input circuit with background suppression is utilized. The MCT backside-illuminated detector arrays have bandgaps suitable for operation in either the 3-5 or 8-12 microns region. Performance characterization of the multiplexer will be given at cryogenic temperatures. Charge transfer efficiency, subthreshold transconductance, threshold voltage, etc. will be presented. These measurements will be compared with ideal models. Characteristics of the hybrid IRFPA have been measured in a wide variety of background.

Cockrun, C.A. et. al., "Development of LPE HgCdTe for Common Modules, Interim Report" November 1982, Santa Barbara Research Center, 109p

A 24-month research and development contract between the SBRC and US Army Night Vision and Electro-Optics Laboratory to develop LPE growth techniques for 0.1ev MCT to the point where standard photoconductive arrays can be produced with high yield.

Conner, A.D., et. al., "Manufacturing Technology, Interim Report," January 1990, Hughes, Santa Barbara Research Center

Extensive producibility and yield data under MANTECH contract. A major article on cost cutting measures on IRFPAs.

Cooper, D.E. et. al., "Spectroscopic Techniques for the Analysis of CdTe Substrates Used for the Growth of MCT," (DTIC Report #AD-A214-545, September 1989) 27p.

Photoluminescence and electron paramagnetic resonance are powerful techniques for both fundamental studies and potential materials screening of CdTe substrates for MCT growth. Certain extended defects that are common in epitaxial CdTe have distinctive PL signature that correlates with X-ray measurements of crystallinity. Bulk samples with prominent subgrain structure also have this PL feature, and cathodoluminescence images show that the defect is localized to the subgrain boundary regions. PL and EPR are very sensitive techniques, and specific impurities such as Fe or Ag have been observed in some nominally pure samples. PL and EPR spectroscopy can also detect changes associated with thermal annealing treatments, which alter the stoichiometry of CdTe by varying the number of Cd vacancies and interstitials. These findings illustrate the versatility of PL and EPR as nondestructive techniques to assess the quality of substrates for IR detector materials.

Crarcy, P.E. and Cathleen M. Farley, "Modeling the Cost and Producibility of INFRA Operability," (BDM International, Inc., 1991) 10pgs.

Extensive mathematical modeling of how IRFPA specifications can drive IRFPA cost and yield. Specifically, IRFPA operability affects IRFPA producibility in two ways, each having an opposite impact. Operability improvements resulting from purer, more perfect materials (fewer defects) become increasingly difficult to achieve as the operability reaches 100 percent. On the other hand, IRFPAs with higher operability have a greater probability of meeting system specifications for defective pixels, and thus final test yields are better. This paper reports on efforts to quantify the latter effect.

Dereniak, E. and Robert E. Sampson, Infrared Detectors and Focal Plane Arrays II, (SPIE: WA) April 1992.

The proceedings include discussions on topics ranging from basic device physics to novel applications. Papers report recent advances and developments in the field, with an emphasis on new concepts. Infrared detector materials such as InSb, MCT, PtSi, GaAs are discussed. Other topics include superlattices, strained superlattices, superconductors, planar hybrid array, z-plane array technology, hybrid input circuits, infrared sensor systems, FPA data processing, cryogenic electronics, and on-FPA signal processing.

Faurie, Jean-Pierre, "Evaluation of the Feasibility and the Cost of HgCdTe Epitaxial Layers Grown by MBE on CdTe, CZT, and GaAs substrates," (DTIC report #AD-A238-602, Jan. 1991) 19p.

In this contract which has been awarded to EPIR Ltd, two tasks were assigned. The first one was related to the evaluation of the cost MCT epitaxial layers grown by MBE on various substrates. The substrates which were supposed to be considered were CdTe, CZT, and GaAs. In addition, EPIR has also analyzed the cost on silicon substrates since Si is currently considered to be the most important substrates for IR photodiode technology. The second task was related to the feasibility of growing a few MCT epilayers by MBE with at least one exhibiting standard specifications.

Faurie, Jean-Pierre, "MBE Growth, Characterization and Electronic Device Processing of MCT, HgZnTe, Related Heterojunctions and MCT-CdTe Superlattices," (DTIC Report #AD-A197-752, December 1987) 42p.

A report is made on growth at the University of Chicago and characterization of high quality MCT epilayers, MBE growth and characterization of two-inch diameter p- and n- type MCT films on GaAs 100 substrate. The n-type intrinsic and extrinsic doping is discussed. The incorporation of As has been photo assisted using a Nd-YAG pulsed laser. X-Ray photoemission of Hg clusters on MCT surfaces has been studied. Direct measurement by XPS and electrical determination of MCT valence band discontinuity give values of 300-400 meV at 300K. Silicon has been used as a n-type dopant to grow a homojunction which electrical characteristics are presented in the paper.

Felix, P. et al., "CCD Readout of Infrared Hybrid Focal Plane Arrays," IEEE Trans. On Electron Devices, (Vol. SC-13, NO. 1, February 1980)

Excellent discussion of a now-mature technology at the outset, namely CCD processing.

Freedman, A. "Patterned Etching of Infrared Detector Arrays," (DTIC Rpt #Ad-A236-124, March 1991) 25p.

The authors attempted to develop a patterned etching technique for infrared detector arrays based on photo-induced processes. The technique is based on the efficacy of methyl radical etching of II-VI compounds such as MCT and CT. Methyl radicals were produced in a pattern above a MCT substrate for photodissociation a radical precursor such as acetone or nitromethane using an excimer laser operating at 193 nm. Neither optical nor scanning electron microscopy could confirm the presence of any etching action. The failure of the proposed technique is ascribed to surface scavenging and/or reaction quenching mechanisms.

"Gallium Arsenide Comes of Age," Financial Times (May 14, 1991), p. 29.

Silicon continues to reign supreme in the market for computer chips, although GaAs offers inherent speed and power advantages, while GaAs transistors consume less energy than silicon transistors. However, working with GaAs has been more difficult and expensive than expected. The DARPA funds for GAAS research may allow breakthroughs in working with the materials (not discussed) and several major manufacturers, including Motorola, are jumping into the market.

Ghandi, S.K. "Research on Mercury Cadmium Telluride," (DTIC Report #AD-A197-238, June 1988), 127p.

This report summarizes work done during the third year of a program entitled Research on MCT. CdTe studies were extended to the DLTS of both n- and p- material. The wide gap materials effort was expanded with the growth of Zinc Selenides, which is lattice matched to GaAs. Significant (200-300 times) improvement in the photoluminescence of GaAs was demonstrated by the use of a pseudomorphic ZnSe layer. The new reactor is fully operational, and is capable of growing HgCdTe with a Cd composition control of  $\pm 0.002$  across a 1cm X 1cm slice. In addition, significant improvement in MCT quality was obtained by the use of CdTeSe substrates. Work with CdTeZn substrates was also carried out during this year.

Guray, A., et. al., "Vapor Transport Epitaxy (VTE), A Novel Technique for Compound Semiconductors," Journal of Vacuum Science and Technology A (July/August 1992) p.1453-1457.

Report from EMCORE Corporation and Rutgers University. An advanced VPE technique for depositing compound semiconductors is described. The technique operates using elemental, gas, or metalorganic sources. The resolving of several problems common to MBE, Chemical-beam epitaxy, and MOCVD systems has been the motivation for investigation of this technique.

Kosnocky, W.F. "State of the Art in Schottky-Barrier IR Image Sensors," (SPIE Paper #1685-01), 19pgs.

Reviews the progress in the development of infrared image sensors with Schottky-barrier detectors. At the present, they represent the most advanced technology for large-area high-density focal plane arrays for many SWIR and MWIR applications. The article is an updated and abbreviated version of recent reviews by the author on progress in the development of infrared image sensors with Schottky-barrier detectors.

Jindal, Bal K. "High Quality Large Area Wafers of Mercury Cadmium Telluride," Xacton Corporation, March 1992, 180p.

Kozlowski, L.J., et. al., "640 X 480 PACE MCT FPA Development for High performance FLIRs," (Rockwell International Science Center, February 1991) 11pgs.

A hybrid 640 X 480 PACE MCT FPA is being developed to meet the needs of many applications including missile seekers and FLIRS. The device will offer full TV resolution with sensitivity much superior to PtSi, having over one-quarter million pixels. The hybrid is comprised of a PACE MCT detector array having nominal 5 micron cut-off wavelength, mated to a high speed CMOS readout having high charge-handling capacity.

Kozlowski, L.J. et. al., "MWIR 256 X 256 PACE-I MCT FPA: Performance Assessment," Proceedings of the IRIS Specialty Group on Detectors (Naval Postgraduate School, Monterey CA) 14-18 August 1989.

Kozlowski, L.J. et. al., "Large Staring IRFPAs of HgCdTe on Alternative Substrates," SPIE International Symposium on Optical Applied Science and Engineering" (San Diego: July 1991). 12pgs.

A report on hybrid MCT 256 X 256 IRFPAs developed at Rockwell International Science Center to meet the sensitivity, resolution, and field-of-view requirements of high-performance medium wavelength infrared imaging systems. The hybrid, also used in a 640 X 480 array still in research, has a MCT detector array mated to silicon-based multiplexers.

Kozlowski, L.J. et. al., "Reproducible High Performance LWIR MCT Staring Focal Plane Arrays," Proceedings of the National IRIS (Johns Hopkins University, Laurel, MD) 12-14 June 1990.

Kozlowski, L.J. et. al., "128 X 128 PACE-I HgCdTe Hybrid FPAs for Thermoelectrically Cooled Applications" Kramer, G., et. al., "Infrared Focal Plane Arrays: A Strategic Defense Initiative Technology Monograph," Jamieson Science and Engineering, June 1991, 264p.

This monograph describes the insights, analytical results, data, and new science and technology that have been created or advanced by six years of R&D applied to sensors FPAs in the context of the Stated Defense Initiative.

Linden, K.J., "MOCVD: Expanding the Range of Photonic Materials," Photonics Spectra (February 1991) 4pgs. Recent research in the semiconductor area has yielded major improvements in device performance as well as new structures based on electron confinement mechanisms resulting in quantum effects. Two methods discussed of epitaxial growth generally used to synthesize such structure are MOCVD and OMVPA, and molecular MBE. More recently developed methods discussed that incorporate elements of both of these

technologies is Chemical Beam Epitaxy (CBE), or Metallorganic Molecular Beam Epitaxy (MOMBE). Reviews significant advances in photonic devices structure achieved by MOCVD.

Lockwood, A.H., et al., "Photovoltaic HgCdTe Hybrid Performance," SPIE (Vol. 267, 1981) 4p.

At the Santa Barbara Research Center, second generation infrared imaging systems require high density focal plane arrays for staring applications. To meet this need, a focal plane structure using MCT photodiodes for detectors and Si CCDs for signal processing has been developed. Although conventional ion-implanted hybrid arrays have successfully been interfaced to CCD multiplexers, hybrid arrays fabricated on LPE layers offer some inherent advantages with respect to performance, processing, and yields. It has been determined that heterostructure diodes fabricated by a Hg infinite melt LPE technique give superior performance relative to conventional ion-implanted devices. Data is presented on devices fabricated for both 8 to 12 microns and 3 to 5 microns applications.

Marciniak, J.W., "Hybrid PV HgCdTe Detectors: Technology Reliability and Failure Physics Program," (DTIC Rpt #AD-A226-675, 1988) 29p.

MCT IRFPAs are finding greater application in systems designed to operate in the MWIR and LWIR. Prior to those IRFPA being deployed in the field, it is important to understand the potential failure mechanisms to permit high reliability units to be built. Indium bump is a widespread method for providing electrical interconnect and mechanical support to these focal planes to circuit boards or silicon multiplexers. This program was designed to evaluate the effect of the hybridization process on MWIR focal planes, as well as assess their long term stability.

McArthur, S.B., "Low-Cost Cooled CCDs Open Doors," Photonics Spectra (January 1992) pp. 92-93.

Discusses how these new CCDs have applications in a broad range of fields for scientists, researchers and engineers.

Moazed, K.L., "MBE Growth of HgCdTe," (DTIC Report #AD-A207-218, June 1980) 21p.

The II-VI compound MCT is a material of considerable interest as a semi-conductor, for optical devices, particularly in the infrared spectral regions. Solid solutions appear to exist for all values of  $x$ , and for values of  $x$  between about 0.2 and 1.0 the material behaves as a semiconductor with a variable bandgap between 0.05 eV and 1.53 eV at room temperature.

Myers, T.H. "Advanced Infrared Focal Plane Concepts," GE Aerospace, March 1992, 180p.

This report describes the results of research carried out under the US Air Force contract "Advanced INFRA Concepts." The overall objective of the program was to advance the state-of-the-art of IRFPA technology through the development of molecular beam epitaxial growth of MCT alloys and HgTe-CdTe superlattices for novel multilayer detector structures for LWIR applications.

National Materials Advisory Board, "Process Challenges in Compound Semiconductors," (DTIC Report #AD-A204-868, August 1988) 154p.

Compound semiconductors, such as GaAs, InP, and MCT, are essential components in future photonics and microelectronics technologies. If the US is to be competitive in these technologies, attention must be directed to the reproducible and affordable processing of these materials. This report assesses the current status of compound semiconductor processing technology and identifies factors that limit the ability to fabricate advanced electronic and optoelectronic devices. Emphasis is placed on current and near-term devices, but the process technology discussed are generic to future components and systems based on these materials.

Niedziela, T. and J. Piotrowski, "Ultimate Performance of CdHgTe Photoelectromagnetic Detectors of Middle and Far Infrared," Journal of Technical Physics (no. 3, 1987), pp. 289-296.

Photoelectromagnetics effect (PEM) finds important applications for ambient temperature IR detectors due to its advantages including no need of electrical supply, the wide response frequency band, absence of low frequency noise and the weak sensitivity on ambient temperature. An attempt was made to evaluate the ultimate performance of the middle and far IR PEM detectors, made of homogenous (Cd, Hg) Te assuming Auger 7 as the dominant recombination mechanisms.

Razeghi, Manijeh, Optoelectronic Materials and Device Concepts (SPIE: WA) November 1990.

The past decade of research and development in optoelectronics has been a continuous interplay between materials improvements and advances in devices, circuits, and system technology. There has been much creative activity in new materials that has led to substantial improvements in devices and systems, and at the same time, the need for newer and better materials having specific properties has been recognized. Contents: Compound semiconductors, strained layer epitaxy, impact of semiconductors on optoelectronic technology, device applications, quantum phenomena, organic materials for optoelectronics, 1990 optoelectronics semiconductors issues, better materials.

Reynolds, R.A., "The II-VI Compounds: 30 Years of Acceptor Dopants in MCT Alloys," Journal of Vacuum Sci and Tech A (Vol. 269, 1989)

Reynolds, R.A., "The II-VI Compounds: 30 Years of History and the Potential for the Next 30 Years," Journal of Vacuum Science and Technology A (March/April 1989) p.269-270.

The past thirty years of progress in II-VI compounds is briefly summarized. Existing problems with both the materials and methods for their production are noted. The probable future uses of the II-VI compound is in infrared sensors and photonics. Possible applications are discussed.

Roberts, C.G. and S.R. Borrello. "Monolithic MCT Focal Plane Array Structures," SPIE (Vol. 217, 1980) 8p.

Sophisticated infrared imaging systems require complex focal plane device structures to perform the basic functions of detection, time delay and integration (TDI), multiplexing, and possible scanning in large array formats with minimal on-focal plane power dissipation. Monolithic MCT charge transfer device structures are promising candidates for many focal plane requirements. CCDs are the natural structure for scanning system IRFPAs which utilize TDI. Charge injection devices (CIDs) are directly applicable to staring system focal plane requirements. This paper discusses the applicability and design considerations of various devices which have been developed using this technology.

Santa Barbara Research Center, "NRL Hybrid Reliability: Physics of Failure Initial Study," (DTIC Report #AD-A217-986, Jan 1990) 71p.

The objective of this program was to identify the failure mechanisms associated with the thermal cycling of MCT hybrid IRFPAs from room temperatures to cryogenic temperature (typically 77K). There is a concern in the IR community that the long-term reliability of IRFPAs may be in question due to defects being formed as a result of the hybridization process and/or thermal cycling of the arrays from room to cryogenic temperatures.

Schetzina, J.F., Device Processing of II-VI Semiconductor Films and Quantum Well Structure (DTIC: March 1991), 4p.

The objective of this program was to develop a device processing technology necessary for proper utilization of Hg-based heterostructures and superlattices in device applications. The specific focus or long term goal guiding the direction of the program was to develop the devices and processing technology required for an

IR focal plane integrated with on-board signal processing electronics.

Schorrocks, N.M., et. al., "Uncooled Infrared Thermal Detector Arrays," (SPIE paper 1320-12).

Excellent review of uncooled IRFPAs, raises issue of strong commercial potential for uncooled arrays because they save money on the cryocooler, a significant cost component.

Scribner, D.A. and Ray Balcerak, Infrared Focal Plane Array Producibility and Related Materials (SPIE: WA) April 1992.

The increasing demand for infrared focal plane arrays for advanced imaging systems has led to several major producibility programs. The proceedings discusses solutions to producibility problems with an emphasis on new concepts and techniques for manufacturing improvements. Production planning and integration are the topics of several papers, including computer integrated manufacturing systems, in-situ process monitoring, and analysis of criteria selection for production. Other topics include packaging and cooling, high throughput testing for improved producibility, and related new materials and their potential with respect to the production of advanced IRFPAs.

Sher, A. Tsigelman, A Eger, D., "Growth of HgZnTe Layers by LPE Technique," (DTIC Report #AD-A198-368, March 1988) 47p.

Report on work at Israel Atomic Energy Commission Yavne Soreq Nuclear Research Center. Solid solution mixtures of a wide band gap II-VI compound with one constituent being the semimetal HgTe may be tuned to yield narrow gap semiconductors, suitable for the fabrication of infrared photon detectors. Among this groups of solid solutions, MCT is at present the most commonly used material for photon detectors. In spite of the scientific and technological achievements difficulties still exist, generally attributed to the instability of these alloys. Thus, theoretical prediction about the relative stability of HgZnTe, reported recently, stimulated experimental research into the narrow band gap range of this solid solution. In the present work the LPE of HgCdTe was studied, focusing on the evaluation of this technique as a tool for achieving epitaxial layers of the "new material" the solid solution HgZnTe, with morphological, crystalline, and electrical properties comparable with those of MCT epilayers.

Smith, L.M., et. al, Integrated Technology in MCT/ GaAs and MCT/ Si for Medium and Long Wavelength Infrared (DTIC: May 1990), 54p.

MCT layers have been grown by MOCVD on CdTe, GaAs, and GaAs/Si for device processing. Both 111 and 100 MCT have been grown on GaAs and the relative merits of the two orientations are discussed.

Stringfellow, G.B. Organometallic Vapor-Phase Epitaxy: Theory and Practice (Academic Press San Diego, 1989).

Excellent review of VPE, and a full discussion of the problems with LPE that pushed VPE to be developed.

Tennant, W.E. "HgCdTe Mid-Wavelength Infrared (MWIR) Epitaxial Mosaics for Tactical Applications," SPIE (Vol. 267, 1981) 5p.

Epitaxial MCT/ CdTe, combined with ion implantation technology, has proven ideally suited for proposed photodiode focal plane array applications. State of the Art performance planar photodiodes have been fabricated in epitaxial materials of all wavelengths. Important applications of these arrays are in tactical defense missions employing MWIR arrays operated at 77K and near 195K. A critical issue for these devices is stability through the bakeout required for the sealing off of dewar packaging. This report presents measurements of ion-implanted MCT/CdTe device and arrays which have broadband spectral response and high RoA values.

Tennant, W.E., et. al., "Key Issues in MCT-Based IRFPAs: An Industry Perspective," (Unpublished article transmitted by author).

The best survey article available on the materials issues confronting the IRFPA industry. Discusses all facets of materials technology which need to be addressed by government funding and proposes innovative ideas for reshaping government spending to spur second generation IRFPA development.

Tong, F.M., Yuan Haoxin and Yang Xiuzhen, "HgCdTe Photovoltaic Detectors and Some Related Aspects," (SPIE Paper #1685-21) April 1992, 11pgs.

Recent developments in HgCdTe photovoltaic detector technology are reviewed. The status of related area in China are introduced. Some aspects of research work on device physics and technology conducted in authors' laboratories are discussed. These include the performance of HgCdTe photodiodes for IR fiber communications, the effects of field-enhanced generation-recombination and imperfections of the pn junction on HgCdTe photodiode I-V characteristics; an analysis of the dependence of energy gap of MCT on temperature compositions.

Tower, John R., "Silicon-Based Imaging: Extending Performance on All Fronts." Photonics Spectra (April 1992), pp. 165-167.

This article discusses how silicon-based sensors are penetrating the market in all sectors from visible wavelength, to UV, to infrared. In the platinum silicide Schottky-barrier market, thermography is a growing business area for industrial process control, energy management, and medical diagnostics (no specifics mentioned). Since John Tower is a manager at the David Sarnoff Research Center, this is mostly an ad for Sarnoff's ability to produce sensors for all IR wavelengths.

Tower, John R., "Staring PtSi IR Cameras: More Diversity, More Applications," Photonics Spectra (February 1991), pp. 103-106.

A thorough review of the technological diversity and applications of PtSi IR cameras which employ PtSi Schottky-Barrier IRFPAs. There is no comparison with MCT or other materials. Discusses the major architectural approaches at the David Sarnoff Research Center for: high frame rate cameras (to aid in understanding failure modes in power semiconductors), multispectral cameras (still in prototype stage), thermography, and infrared acquisition and tracking systems (military)

Tsaur, Bor-Yeu, et. al., "PtSi Schottky-Barrier Focal Plane Arrays for Multispectral Imaging in Ultraviolet, Visible, and Infrared Spectral Bands," IEEE Electron Device Letters (April 1990), p162-164.

PtSi Schottky-barrier detectors, which are conventionally used in the back-illumination mode for thermal imaging in the 3-5 micron infrared spectral band, are shown to exhibit excellent photoresponse in the near-ultraviolet and visible regions when operated in the front-illuminated mode. For devices without antireflection coatings, external quantum efficiency in excess of 60% has been obtained for wavelengths between 400 and 800 microns. The efficiency decreases below 400 microns but is still about 35% at 290 microns.

Voeiker, Jeffrey, "Dual-Band Focal Plane Array Trade Studies," General Electric Company Electronics Lab, January 1992, 23p.

Details results of a study that examined the current state-of-the-art of two IRFPA technologies: InSb 3-5um, and PV HgCdTe 8-12. Advanced techniques, such as MBE, MOCVD, and to a lesser extent LPE offer the promise of greater uniformity, operability, and detectivity, but wide-spread use of devices fabricated in these ways are currently cost prohibitive. The principal focus of this effort centered on characterizing the limitations imposed by current growth and process techniques on the ability of devices to function radiometrically.

Vu, TT et al., "Integrated GaAs Readout Multiplexer and Preprocessing Electronics for Infrared Sensors," IEEE International Symposium on Circuits and Systems (New Orleans, LA May 1-3 1990), pp. 3093-3096.

A thorough, technical report on the use of gallium arsenide technology for IRFPA sensors. GaAs's characteristics, circuits, and architectures for readout multiplexer and preprocessing electronics are described for the first time in open literature for both scanning and staring arrays.

Vural, Cadri, "Mercury Cadmium Telluride Hybrid Focal Plane Array Technology," Proceedings of the SPIE Conference on Lasers and Electro-Optics (April 25-29 1988), pp. 28-29.

The MCT hybrid FPA, microelectronics chip architecture that emulates in the IR the function of Si visible imagers is discussed. As MCT is an alloy semiconductor whose bandgap can be varied from greater than 1 eV to less than 0.1eV, a hybrid FPA can be made with an IR long-wavelength cutoff from 1 to less than 10 microns. The development is reported of large arrays in two spectral bands: 1-2.5 microns (SWIR) and 3-5 microns (MWIR). The SWIR FPA has its principal application in earth resources and astronomy, while the MWIR FPA is useful in passive thermal imaging. The architecture and performance of the arrays are reported.

Vural, Cadri and L.J. Kozlowski, "256 X 256 MCT IRFPAs for the Hubble Space Telescope," (SPIE Paper 1320-14) 1990.

Excellent article on specifications and technological techniques for the most advanced and reliable MCT IRFPAs produced.

Watton, R., M.A. Todd, and J.P. Gillham, "Materials and Technology Research in Uncooled Ferroelectric IR Detector Arrays," IEEE Transaction Papers (Date Unknown), pp. 69-77.

An extremely technical piece which proposes an altogether new material for IRFPAs, using iron based material. The technology for the fabrication of large hybrid pyroelectric (thermasense) arrays has been established using the lead compound perovskite ceramics. These IRFPAs would operate at ambient temperature, and the absence of cryogenic requirements eases the operation, particularly in remote situations. The major drawback of the technology, expense, is not explained because the ferroelectric proposal is still in the prototype stage.

West, S.A., et. al., "Producible MWIR MCT Detector Array Program Intermediate Production Performance," August 1989, Rockwell International.

Interim report on Rockwell's MANTECH program. An essential document on yield and producibility technologies.

Williams, G.M., "Development of LPE HgCdTe for 305 Micron by PV Diode Arrays," Rockwell International Science Center, August 1988, 134p.

Final Report

Williams, T.L. and B. Newton "In Situ Testing of FLIRs and other Thermal Images," (SPIE Paper 1320-50) 1990, 9 pgs.

Discusses work at Sira, Ltd, in United Kingdom on reducing costs of FLIR testing by using in situ testing to determine faults as they occur so that material can be modified in situ instead of being discarded. This is a technology to watch closely.

Woolaway, James T, "New Sensor Technology for the 3- to-5 Micron Imaging Band," Photonics Spectra (February 1991), pp. 113-119.

The author discusses tradeoffs in IRFPAs operating in the 3-5 micron or the 8-12 micron band. He explains that sensors in the 3-5 micron range offer higher contrast, but receives more solar noise, and has lower radiance, particularly at low background temperatures. By contrast, the 8-12 micron range has a higher radiance, and higher thermal derivative (ie. it reacts faster to light). Since the 3-5 micron band offers



potentially better resolution, technological efforts are focused on imaging systems which can better filter the background noise, and elucidate the image better.

Yasuta, Brian, "Tower Video Signal-To-Noise Ratios of TICM II and Mitsubishi 512X512 PtSi Sensors," Wright Lab, Wright Patterson AFB, March 1992, 198p.

The PtSi Sensor Program reports on comparisons of these PtSi detectors with MCT and InSb detectors. PtSi sensors are evaluated for their potential as a low cost alternative to HgCdTe and InSb detectors for imaging applications. To accomplish this goal, these sensors are compared in the laboratory and under a variety of weather conditions in the field (tower) to determine the capabilities of the PtSi sensors for Air Force missions in all environments.

Zanio, K.R., "Hg<sub>1-x</sub>Cd<sub>x</sub>Te on Si for Hybrid and Monolithic FPAs," (SPIE Paper 1308-14), 1990, 15pgs.

Discussion of work underway at Ford Aerospace on MCT using silicon as an alternative substrate.

#### **(iv) Applications of IR Sensitive Materials in Biomedical Thermography**

Afromowitz, et. al., "Multispectral Imaging of Burn Wounds: A New Clinical Instrument for Evaluating Burn Depth," IEEE Trans Biomed Eng (1988:10) 842-849.

Predecessor to Hejazi study. Found that multispectral imaging could help determine absolute temperatures of skin, independent of emissivity.

Alfano, R., Ping P.Ho and K.M. Yoo, "Optical Imaging vs. X-rays for Breast Cancer Screening," Photonics Spectra (October 1992), p.109-113.

A professor at City College of the City University of New York discusses the novel technique of using infrared scanning as an alternative, safer, and higher resolution technique than x-rays (the conventional technique) for breast cancer screening.

Allen, R.C., et. al., "Localized Scleroderma: Treatment Response Measure by Infrared Thermography," Thermology (1987:2) pp. 550-553.

Amalric, R., et. al., "Prognostic Use of Thermography in Breast Cancer," International Congress of Thermology (August 1992).

Found that breast cancer with temperature increases of more than 3°C had a high failure risk, and "deserves systematic additional medical treatment."

American Medical Association, "Thermography in Neurological and Musculoskeletal Conditions," Reprinted in Thermology (1987:2) pp. 600-607.

Very conservative study which approved positively of thermography but concluded that thermography was not useful in directly measuring pain, and that more studies were needed to support its use.

Anbar, M. "Objective Assessment of Clinical Computerized Thermal Images," Processings of SPIE Medical Society V: Image Processing SPIE Proceedings (1991; 1445) pp. 845-847.

Echoes Anbar's main theme, that quantitative thermography will overtake biomedical thermography applications. Also notable because is written in public forum, rather than the "trade journal," Thermology.

- Anbar, M., "Recent Technological Developments in Thermology and their Impact on Clinical Applications," (Unpublished), 13 pgs.  
Reviews three new major technological developments in thermology: quantitative thermology, dynamic thermology, and absolute temperature thermology. Concludes absolute temperature thermology will prevail, because it provides quantitative thermological info free from artifacts associated with the measurement of infrared flux at a single wavelength band. It also measures the emissivity of the skin, which may have independent diagnostic applications, especially in the field of dermatology.
- Anbar, M. D'Arcy, S.J. "Localized Regulatory Frequencies of Human Skin Temperature Derived from the Analysis of Series of INfrared Images" Proc. of the 4th Annual IEEE Symposium on Computer Based Medical Systems (CBMS '91) (1991) 184-191
- "A New Method for Detecting Cervical Cancer," Photonics Spectra (February 1992) p.106  
A promising new method for detecting cervical cancer is currently being developed and tested at the New York Hospital-Cornell Medical Center and Canada's National Research Council. The method, which employs infrared spectroscopic analysis of human cervical cells, may eventually lead to a new, rapid diagnostic test for the disease.
- Clark, R.P., "Medical Thermography: Current Status," (SPIE Paper 1320-27) 1990.  
Although the discussion revolves around thermography, almost all of these applications are suffering without IRFPAs, and this article highlights areas where IRFPAs would be extremely helpful because of their window of IR imaging, and resolution quality.
- Clark, R.P., Goff, M.R., and Culley, J.E., "High Resolution Thermography in Medicine," The Journal of Photographic Science (Vol. 37, 1989), pp. 168-171.  
Explains advancements in biomedical diagnosis made possible by a high resolution medical thermal imaging system using an 8 element SPRITE detector.
- Clark, R.P., et. al., "Thermography and Pedobarography in the Assessment of Tissue Damage in Neuropathic and Atherosclerotic Feet," Thermology (3: 1988), pp. 15-20.  
Discusses application of thermography in these two disciplines.
- Croissant, P.D., et. al., "Neurological Clinical Procedure Review," Joint Council of State Neurosurgical Societies of the American Association of Neurological Surgeons and the Congress of Neurological Surgeons (June 1988) 4 pgs.  
This is the lukewarm endorsement of thermography by the technology assessment committee of the American Assoc of Neurological Surgeons. It concluded thermography was safe and effective, but is to be considered an adjunctive test and not solely diagnostic except in cases of reflex sympathetic dystrophy.
- DeMey, F., and R. Vermeir, "A Tutorial of Infrared Thermography," Meeting of International Congress of Thermology (August 1992).  
Offers general overview of IR thermography, starting from basic physical principles, the mechanics of IR equipment, and emissivity correction.
- Fujimasa, I., "Current Status of Medical Thermography in Japan," International Congress of Thermology (August 1992).  
Discusses evolution of machines used and diseases diagnosed with thermography since 1968 in Japan.
- Goodman, P.H., "Cost-Effective Analysis of Thermography and Venography in the Diagnosis of Deep Vein Thrombosis," Thermology (1989:3), pp. 113-120.

Argues that thermography should be used before taking expensive chemical or surgical procedures to remove deep vein thrombosis, because it could possibly save patients thousands of dollars by corroborating or sometimes contradicting diagnoses made by other, more prevalent equipment.

Handelsman, H., "Thermography for Indications Other Than Breast Lesions," Office of Health Technology Assessment, US Department of Health and Human Services (1989).

A negative review which argued that thermology is not effective in medical diagnoses.

Hejazi, S., Wobschall, D.C., Spangler, R.A., and Anbar, M. "Scope and Limitations of Thermal IMaging Using Multi-wavelength Infrared Detection," Optical Engineering (November 1992), pp. 2383-2393.

Reports on a single experiment which successfully determined absolute temperatures of surfaces by their blackbody emissions, by simultaneous acquisition of infrared emissions at different wavelengths.

Hubbard, J.E., "Neuromuscular Thermography: An Analysis of Criticisms," Thermology (1990:3) pp. 160-165.

Examines the critical points and issues raised by the criticisms of the AMA, Joint Council of State Neurosurgical Societies, the Office of Health Technology Assessment, the the American Academy of Neurology.

Hubbard, J.E., "Pain Evaluation in 805 Studies by Infrared Imaging," Thermology (1986:1) pp. 161-66.

Compares diagnostic precision of IR thermography with CT scans, EMG, and myelography for evaluation of pain in lumbar, cervical, thoracic, and facial areas. Found that IR thermography is clinically useful in pain evaluation as an indicator of peripheral nerve patho-physiology.

Jankel, W.R., Uematsu, S., "Thermography in Neurological Evaluation," Curr Ther Neurolog Surg (1989:2) pp. 331-34.

Very positive, objective review of usefulness of thermography in these diagnoses.

Jones, C.H., Ring, E.F.J., and R.P. Clark, "Biomedical Thermography," in Burney, S.G., Williams, T.L., Jones, C.H.N., Applications of Thermal Imaging (Adam Hilger: Philadelphia) 1988.

Discusses both technical aspects of biomedical IR, and all major areas in which their use has been proposed.

LeRoy, P. and R. Filasky, "Thermography," in J.J. Bonica, J.D. Loeser, C.R. Chapman (eds.), The Management of Pain, 2nd edition. (Lea & Febiger: Philadelphia) 1990, Volume 1, pp. 610-621.

Mohr, F.W., et. al., "Thermal Coronary Angiography: A Method for Assessing Graft Patency and Coronary Anatomy to Coronary Bypass Surgery," Ann THorac Surg (1989:47) pp.441-449.

Montoro, J.C., Anbar, M. "Visualization and Analysis of Dynamic Thermographic Changes," Proc. of the First Conference on Visualization in Biomedical Computing. (1990) pp.486-489.

Discusses reading and understanding clinical information embedded in absolute temperature thermal scans of bodies.

Montoro, J.C., Hershey, LA and Anbar, M., "Enhancement of Interpretation of Thermograms Through On-Line Software" Thermology (1989:3) pp. 121-124

Explains how radiometric readings and dynamic diagnoses can be made through the softwre available currently.

Nyirjesy, N., et. al., "Clinical Evaluation, Mammography and Thermography in the Diagnosis of Breast Carcinoma,"

Thermology (1986:1) pp. 170-173.

Concludes that the three major techniques used to evaluate the state of health of the mammary gland, namely clinical evaluation, mammography, and thermography, have inherent inaccuracies and cannot be used alone, either in screening or in diagnostic examinations. Recommends using IR thermography in conjunction with other these other methods.

Ohashi, Y., etl. al., "Significance of Dynamic Thermography in the Diagnosis of Breast Cancer," "International Congress of Thermology (August 1992).

Pavot, A.P., Ignacio, D., and Gargour, G, "Use of Thermography in the Diagnosis and Management of Reflex Sympathetic Dystrophy," International Congress of Thermology (August 1992).

Authors found that IR imaging, with its characteristic abnormal temperature pattern, is very useful in confirming the diagnosis of RSD. Technique also found useful in monitoring sympthetic nerve blocks and determining the adequacy of sympathectomy, both of which are used commonly in treatment of the disease.

Pochaczewsky, R., "Status of Thermography: 1989," Thermology (1989:2) pp. 97-100.

Good overview of potential applications. Emphasizes that thermology images the heat produced by body processes, rather than the imaging the processes directly; author contends this misunderstanding has led to low confidence of medical public in thermography.

Pochaczewsky, R., "The Value of Thermography as a Clinical Imaging Diagnostic Test: A Review of and Response to the 1989 Office of Health Technology Assessment Report of Thermography for Indications Other than Breast Lesions," Thermology (1991:4), pp. 227-233.

Pochaczewsky, R., "Thermography in Posttraumatic Pain," Am J of Sports Medicine (1987:15) p.243-250

A how-to article targeted at physicians interested in thermography and its applications to sympathetically maintained pain, resulting from sports injuries.

Ring, E.F., "Thermography in Rheumatology," Thermology (1986:1) pp. 149-153.

Pioneering experiment, using late-model IR machines, to diagnose and follow treatment of rheumatology through the temperature given off by peripheral joints, which varies in accordance to the synovial blood flow and inflammation.

Sterns, E.E., Zee, B., "Thermography as a Predictor of Prognosis in Cancer of the Breast," Cancer (1991:67) pp. 1678-1680.

Although recognizing the significance of biomedical thermography equipment, remains skeptical about reaching close to 100 percent confidence in thermography as a prognostic technique.

Stoner, H.B., Taylor, L., Marcuson, R.W. "The Value of Skin Temperature Measurements in Forecasting the Healing of a Below-Knee Amputation for End-Stage Ischemia of the Leg in Peripheral Vascular Disease," Eur J Vasc Surg (1989:3) pp. 255-261.

Suave, C., Hand, D., Thomassin, L., Amalric, R. "The Diagnosis and Prognosis of Thermography in Breast Cancers," International Congress of Thermology (August 1992).

Found direct correlation between temperatures of cancerous breast tumors, and mortality. Recommends use of IR thermography in making prognoses for patients found to have breast cancer.

Thomassin, L., Giraud, D., Sauvc, C., Amalric, R., "The Value of Thermography in Small Size Breast Cancer" International Congress of Thermology (August 1992).

Found thermography to be modestly effective in the diagnosis of small breast cancer tumors. Recommends that thermography be an integral diagnostic technique for breast cancer diagnosis, coupled with other techniques.

Torres, J.H., Springer, T.A., Welch, A.J., Pearce, J.A., "Limitations of a Thermal Camera in Measuring Surface Temperature of Laser-irradiated Tissues," Lasers Sur Med (1990;10) pp. 510-23.

Uematsu, G. "Thermographic Imaging of Cutaneous Sensory Segment in Patients with Peripheral Nerve Injury: Skin Temperature Stability Between Sides of the Body," J of Neurosurgery (1985;62) pp. 716-720.

Ulmer, H.U., Brinkmann, M. Frischbier, H.J. "Thermography in the Follow-up of Breast Cancer Patients After Breast Conserving Treatment by Tumorectomy and Radiation Therapy," Cancer (1990; 65) pp.276-80. Concludes that thermography does serve a valuable role in follow-up procedures.

Wagter, C. De, Martens, L. "Hyperthermia State of the Art: Physical and Technological Aspects," International Congress of Thermology (August 1992).

Proposes use of biomedical thermography to ensure that the heat differential and heat dynamics in the body do not thwart attempts to heat cancerous tumors to very specific temperatures, in order to kill the tumor.

Yoo, K.M., Das, B.B., and Alfano, R.R., "Imaging of a Translucent Object Hidden in a Highly Scattering Medium from the Early Portion of the Diffuse Component of a Transmitted Ultrafast Laser Pulse," Optics Letter (July 1, 1992) pp. 958-60.

Presents scientific basis for use of thermography in breast cancer diagnosis.

#### **(v) Applications of IR Sensitive Materials in Non-Destructive Evaluation**

Blazquez, C.H., "Detection of Citrus Freeze Damage with Natural Color and Color Infrared Video Systems," SPIE Thermosense XIII Conference (April 1991) pp. 394-401.

Infrared videography was used, but wavelength is in SWIR, making the application probably unavailable to MCT-based detectors.

Brocher, V.H., "Recent Advances in Inspecting Integrated Circuits for Pattern Defects," (SPIE Paper #1661-296) 1992, 16pgs.

Use of infrared detectors is discussed for inspection of IC boards; technical description of how the closed-loop inspection regime is arranged and run.

Bruno, Robert P., "Thermography in Nondestructive Industrial Testing," Photonics Spectra (July 1989), pp. 123-24.

Thermal imaging, or thermography, is now being used effectively as a tool for inspecting the integrity of composite materials and the adhesion of bonded protective overcoatings. The thermographic inspection of metals for stress-induced cracking now showing promise. Applications in metals are discussed.

Bruno, Robert P., "Tracking Gas Leaks with Active IR Scanning," Photonics Spectra, (February 1992) pp. 94-98.

Discusses how an IR laser can shine on an area and visually reveal where gas is leaking. This is because various gases have a different light absorption band than ordinary air. This is an interesting breakthrough because it shows how spectroscopy (usually without IRFPAs) begins to work more like focal plane arrays. FPA's in fact would make this process much more efficient and simpler if only the technology became

cheaper.

- Cantella, M.J. et al., "Application of IR Staring Arrays to Space Surveillance," (SPIE Paper #1540-75) 1991, 20pgs. Best overview in the bibliography of the technologies, applications, and techniques for space-based second generation photovoltaic IRFPAs.
- Cawley, P. and R.D. Adams, "Defect Types and Non-Destructive Testing Techniques for Composites and Bonded Joints," Materials Science and Technology (May 1989), pp. 413-25.  
In this paper, an introduction to the aspects of composites and adhesive joints relevant to non-destructive testing is provided. The first part consists of a brief introduction to composites and adhesive joints, together with a description of the types of defects that may occur. In the second part, the main relevant non-destructive techniques used to identify these defects are described and the sensitivity of each method to the different types of defect is indicated. Thermographic inspection is described and discussed.
- Cramer, K.E., P.A. Howell, W.P. Winfree, "Quantitative Thermal Depth Imaging of Subsurface Damage in Insulating Materials," SPIE Thermosense XV Conference (April 1993) Paper 1933-24.  
Another application for Langley Research Center's pulse-echo thermal-wave imaging.
- Cramer, K.E., P.A. Howell, W.P. Winfree, "Quantitative Thermal Depth Imaging of Subsurface Damage in Insulating Materials," Unpublished 10 pgs.  
A thermal technique is presented for imaging subsurface damage and computing the depth of defects. This technique has been used in the detection of defects in aging aircraft skins.
- Davis, Roy C., A Robotic Workcell for Linear Welding/Thermovision Scanning of Thermoplastic Bumpers (SME: 1984), 9 pgs.  
This article is old but pertinent. The Ford Motor Company's Milan plastics plant utilized infrared scanning of a linear welded plastic bumper utilizing the robotic workcell concept. Buchanan, R.A., P.E. Condon, L.M. Klynn, "Recent Advances in Digital Thermography for Nondestructive Evaluation," SPIE Thermosense XII Conference (April 1990) pp. 134-142.
- Ellingson, W.A., "Defect Detection in Multilayers Plasma-Sprayed ZrO<sub>2</sub> by Time-Resolved Infrared Radiometry: A Comparison Between Analytical and Experimental Methods," SPIE Thermosense XV Conference (April 1993) Paper 1933-17.  
Discusses a high-end NDE application of IRFPAs. More down-to-earth, common inspections may derive their techniques from the one explained in this article.
- Favro, L.D., "Inversion of Pulse-Echo Thermal-Wave Images," SPIE Thermosense XV Conference (April 1993) Paper 1933-15.  
Advocates a new data processing technique for improving thermal-wave images, which is a technique being improved for the assessment of aging-aircraft and advanced composite metals.
- Favro, L.D., et al., "Infrared Thermal-Wave Studies of Coatings and Composites," SPIE Thermosense XIII Conference (April 1991) pp. 290-294.  
Although focuses on high-tech coatings and composites, explains system which will likely become model for later, mass-produced machines for more down-to-earth applications.
- Favro, L.D., P.K. Kuo, R.L. Thomas, "Real-Time Thermal Wave Imaging," Unpublished 27 pgs.  
Extremely technical piece on this technique originally used by the researchers for detection of delaminations

and defects in aging aircraft skins.

Favro, L.D., et. al., "Real-Time Thermal Wave Tomography," in D. Bicanic (ed) Photoacoustic and Photothermal Phenomena III (Springer Verlag: 1992) pp. 519-45.

Images from thermal wave tomography have often been blurred because heat from the strobe lights diffuses out in the material. The authors contend that the diffusion can be easily removed from images if the data is correctly processed.

Favro, L.D., et. al., "Thermal Wave Detection and Analysis of Adhesion Disbonds and Corrosion in Aircraft Panels," in D.O. Thompson, D> CHimentu, Review of Progress in Quantitative Nondestructive Evaluation (Plenum Press: 1993) 5 pgs.

Feit, Edward, "Infrared Thermography for Aerospace NDT," Advanced Imaging (March 1991), 2 pgs.

The author outlines how the Physical Properties Laboratory at General Dynamics's Space Systems Division (San Diego) is using thermography for nondestructive testing, rocket plume studies, to observe materials under simulated re-entry conditions, to visualize gaseous leaks, and to find defects in circuit boards. A good overview.

Finney, P., "Use Thermography to Pinpoint Faults," Test & Measurement World (November 1992) pp. 43-44.

No other test equipment can detect printed circuit board faults as well as infrared thermography. This article explains the usage, application, and different levels of integration of the testing equipment.

Gartenberg, E., A.S. Roberts, Jr., "Twenty-Five Years of Aerodynamic Research with Infrared Imaging," SPIE Thermosense XIII Conference (April 1991) pp.338-356.

Used as a reference piece; this is a pure research application with no wide-spread use.

Hadjifotiou, A., "Coherent Optical Systems: Current Status and Future Prospects," SPIE Sponsored Conference on Fiber Optics '90 (April 24-26 1990), pp. 14-24.

A case history is presented in which infrared imaging is used to locate shorts in a complex printed wiring board. Passing current through the short heats the conductor trace, and the current path is delineated on the IR image. This method is shown to be useful for a variety of current-carrying structures, both for failure analysis and reverse engineering. It can often be used with very limited knowledge of the detailed function of the device.

Hamilton, A., Childs E., and Marcia Kunz, Infrared Thermographic Evaluation of Fiber-Reinforced Composite Structures with Honeycomb and Closed-Cell Cores (SME: 1989), 26 pgs.

The planned utilization of closed-cell core in aircraft applications where honeycomb had been used previously and the fabrication of more complex shaped honeycomb parts, has necessitated the development of advanced NDE techniques for the purpose of assessing the quality of these structures. Infrared thermography has been identified as a viable candidate for evaluating bonded structures that are difficult or impossible to evaluate using conventional ultrasonics. Infrared thermographic inspection can be applied to these structures after an extensive qualification effort has been successfully concluded. The selective implementation of infrared thermography can reap both technical and economic benefits. The results of two distinct qualification projects, one involving sandwich structures having closed-cell core and the other, honeycomb core, are described.

Hamrelius, T., "Accurate Temperature Measurement in Thermography: An Overview of Relevant Features, Parameters, and Definitions," SPIE Thermosense XIII Conference (April 1991) pp. 448-457.

This piece applied to all areas of application, not just NDE.

Howell, P.A., W.P. Winfree, B.S. Crews, "Numerical Simulations of Thermal Detection of Disbonds in Lap Joints, in Review of Progress in Quantitative NonDestructive Evaluation, Thompson, D.O., D.E. Chimenti, (eds.) Vol. 10B, 1991, pp. 1367-73.

Howell, P.A., W.P. Winfree, B. X. Crews, E. Cramer, "Parametric Studies of Thermographic Detection of Disbonds in Laminated Structures Using Computational Simulations," in Review of Progress in Quantitative NDE, Thompson, D.O., D.E. Chimenti (eds.) Vol. 9, 1990, pp. 1263-69

"IR Method Identifies Surface Contaminants," Chemical and Engineering News (Date Unknown in 1990), p.56.  
A new form of microscopy developed by the Sandia National Labs, called IR microprofiling, uses a precise scanning movement of the microscopic stage to profile an entire region, pixel by pixel. (note: This sounds very much like the role IRFPAs now play, and it shows an area in which IRFPAs may make a good contribution if prices come down.)

Jones, T.S., H. Berger, and E. Weaver, "Large-Area Thermographic Inspection of CRP Composite Marine Vessel Hulls," SPIE Thermosense XV Conference (April 1993) Paper 1933-25.  
Another application of IR systems designed for inspection of aging aircraft skins.

Luong, M.P., "Infrared Thermographic Characterization of Engineering Materials," Proceedings of the SPIE v. 1341 (July 11-13, 1990), pp. 327-338.  
This paper illustrates the use of infrared thermography as a nondestructive and noncontact technique (a) to observe the physical processes of unstable crack propagation or flaw coalescence of engineering materials subject to various loadings, (b) to detect material defects or leakage phenomena and (c) to aid tribology experiments.

Lutovinov, V.M. et. al., "Some ways of using Thermal Imaging in Aeromechanics," Fluid Mechanics, Soviet Research (March-April 1990) pp. 82-91.  
There are four main possible uses of thermal imaging systems in aeromechanics: measurement of temperature distributions on the bodies, experimental determination of points of extreme temperature on a given surface, measurement of the rate of heating of a surface, the motion of isotherms (e.g. for determining the heat flows to the surface), and monitoring changes in surface temperature in order to maintain it in a given range with the help of some other means (e.g. by cooling). Many applications in aeromechanics do not require temperature calculations, but instead qualitative analyses of the distribution of extreme heat transfer values and methods of controlling it. Thermal imaging systems are very effective in such cases. There is no doubt that most of the information thus derived requires computer processing.

Mackay, C.D., "Cooled CCDs in Lab Spectroscopy: The System of Choice," Photonics Spectra (February 1992) pp. 113-116  
Cooled CCD systems are now the detector of choice, according to this article, in a wide range of imaging applications, and in recent years they have become the fastest-growing detector system for laboratory spectroscopy. Explains how CCDs are suited well to spectroscopy and what developments one can expect in the next few years.

Madrid, Angel, "Using IR Thermography for Detecting and Diagnosing Cracking in Concrete Dams," Conference on Infrared Technology XVI; Proceedings of the SPIE (July 11-13 1990), pp. 110-126.  
Analytical and experimental research has been concluded to assess the feasibility of detecting and diagnosing deep crack in concrete dams by means of IR thermography measurements. A simplified, scale-down model of the nonoverflow section in a conventional concrete gravity dam and its reservoir has been designed with the capability of simulating both air-filled and water-filled deep cracks. A high-resolution



CMT thermal imager (BSI 7000 equipment) has been utilized for mapping the temperatures at the downstream face of the latter mode, under realistic quasi-static thermal conditions, in similar situations both with and without deep cracks present in the concrete body. The results obtained from these measurements compare reasonably well with calculations based on an ad hoc one-dimensional heat-transfer model of the simulated dam-reservoir complex.

Maldague, X., et. al., "Transient Thermographic NDE of Turbine Blades," SPIE Conference on Thermosense XII (1991) pp. 161-171.

McLaughlin, P.V., Jr., "Defect Detection and Quantification in Laminated Composites by EATF (Passive) Thermography," Review of Progress in Quantitative Nondestructive Evaluation (v7B, 1988), pp. 1125-1132.

The capabilities and limitations of externally applied thermal field (EATF) thermography are presented along with applications for which it seems best suited. Heating methods are reviewed for both parallel and normal EATF thermography. Liquid crystal and video radiometers are assessed for their temperature measurement sensitivities and ranges and techniques for the analysis of EATF thermographic phenomena are given. Detection and quantification of debonds and surface cracks are discussed along with ambient surface condition and support structure effects. Directors for future development of the technique are highlighted.

McLaughlin, P.V. Jr., "Using EATF Thermography for Nondestructive Evaluation," Plastics Engineering (July 1988), pp. 47-50.

The externally applied thermal field (EATF) thermographic technique for nondestructive evaluation (NDE) is capable of detecting surface and subsurface flaws, such as surface cracks and delaminations, in laminated composites during routine inspections. EATF thermography can also be used to quantify delaminations and impact damage.

Ramamurthy, A.C., et. al., "Stone Impact Damage to Automotive Paint Finishes: Post Impact Damage Analysis," International Congress and Exposition of the Engineering Society for Advanced Mobility Land Sea Air and Space (March 1993) 19 pgs.

Discusses several technique to assess paint chips and dents in automotive bodies after the impact of stones, such as Electrochemical Impedance Spectroscopy, Thermal Wave Imaging, and Acoustic Microscopy. The authors do not unfortunately discuss the market potential (which appears very limited).

Reizman, F., "Fault Location in Printed Wiring Boards Using Thermal Imaging," SPIE Thermosense XII (April 1990) pp. 172-177.

Early article on a very popular application.

Selman, J.J., "Evaluation of a Prototype Thermal Wave Imaging System for NDE of Composite and Aluminum Aerospace Structures," SPIE Thermosense XV Conference (April 1993) Paper 1933-22.

Shephard, S.M., et. al., "Comparison of Scanning and PtSi Focal Plane Array Cameras for IR Thermal Wave Imaging," SPIE Thermosense XV (April 1993) Paper 1933-16.

Concludes that although scanning systems are more predictable and calibrated better, staring PtSi cameras should offer improved resolution, sensitivity, and faster frame rates, which should be a boon for thermal wave imaging.

Snell, J.R., "A High-Tech Tool Meets Low-Income Weatherization," Home Energy (May/June 1989) 6 pgs.

Infrared thermography equipment has come down in price to the point where weatherization programs can fully utilize them. This article describes how weatherization programs use this equipment, and what they

specifically look for.

Snell, J.R., "A Survey of the Use of Infrared Thermography in the Department of Energy's Weatherization Assistance Program," SPIE Thermosense XI 1989 (August 1989).

The Low Income Weatherization Assistance program, administered by the Department of Energy, aims to reduce the energy consumptions of homes owned by lower income families. In the past four years, infrared thermography has become a central tool used by energy assessors to locate air leaks around windows, holes in walls, faulty heating or cooling ducts, etc.

Snell, J.R., "Moisture in Roofs: What to do About it," Roofer Magazine (October 1990) 6 pgs.

Infrared detectors can be instrumental in the location of moisture deposits in roof, which can spread and eventually require roof replacement.

Spicer, J.W., W.D. Kerns, L.C. Aamodi, J.C. Murphy, "Time-Resolved Infrared Radiometry Using Focal Plane Arrays for Characterization of Hidden Corrosion," SPIE Thermosense XV Conference (April 1993) Paper 1933-18.

More garden-variety corrosion detection techniques using IR would probably be derived from the technique explained here.

Syed, H.I., and K.E. Cramer, "Corrosion Detection in Aircraft Skin," SPIE Thermosense XV Conference (April 1993) Paper 1933-19.

Explains the major effort, being conducted at Langley Air Force Base under NASA's auspices, to use IR pulse-echo thermal-wave imagery to detect flaws in aging aircraft skin.

Tenek, L.H., E.G. Henneke, "Flaw Dynamics and Vibrothermographic-Thermoelastic NonDestructive Evaluation of Advanced Composite Materials," SPIE Thermosense XIII Conference (April 1991) pp.252-263.

Earlier article on testing metal construction materials for stress, using "stress photonics," techniques, such as IR.

Thielen, D.A., "Infrared Thermographic Inspection of Superelastically Formed/ Diffusion Bonded Titanium Structures," SPIE Thermosense XV Conference (April 1993) Paper 1933-21.

Discusses a specific, high-end application of IRFPAs in composite inspection.

Thomas, R.L., L.D. Fabro, P.K. Kuo, R. Bruno, "Using Thermal Wave Imaging to See Below the Surface," Photonics Spectra (January 1993) pp. 147-150.

Thun, R.L., "Thermographic Inspection of Composite Aerostructures," SPIE Thermosense XV Conference (April 1993) Paper 1933-23.

Describes use of infrared imaging techniques, contrasting it with ultrasonic techniques, the traditional method.

Titman, D.J., "Some Applications of Infra-Red Thermography to Civil Engineering Problems," British Journal of Non-Destructive Testing (December 1990), pp. 627-630.

Thermography is totally non-destructive and under suitable conditions can provide a rapid hands off approach to an investigation. However, as with other non-destructive tests, it may be necessary to correlate results with other forms of inspection, utilizing other non-destructive techniques. This paper concentrates on applications of the technique to the investigation of structural details and defects. Subject covered included conditions under which the technique may be useful, applications involving a heat source within a structure, thermal gradients, and induced heating, and practical considerations.

Traub, A.C., "Parts Inspection by Laser Beam Heat Injection," NDT International (April 1988), pp. 63-69.

When a pulse of laser radiation falls on a material surface, a certain amount of warming will occur which depends upon the surface properties of the material, particularly upon its absorptivity. The amount of warming will also depend upon what is underneath the surface and especially upon the amount of mass which is available for the thermal energy to expand into. If the warming process is monitored by an infrared detection system, one has a ready means of determining whether or not two parts are alike in their surface properties or in their internal features. An automatic, non-contact system is described which uses this principle for the inspection of solder joints on printed wiring boards at rates of up to 10 joints per second. With minor changes, the inspection system can be used to repair defective joints and to manufacture new ones by the reflow of solder paste or preforms. Extensions of the inspection method are described with regard to the testing of bonds in metal sheets and to the measurement of paint thicknesses on metals.

Vogel, C., "The Art Market: When the Crowds Go Home, Museum Officials Peek Behind the Scenes, Literally," New York Times (February 5, 1993), pp. C24.

The use of infrared video cameras to closely examine great artworks on loan to museums is discussed. The Museum of Modern Art in New York City recently learned a great deal about Matisse works using the cameras.

Warren, L. and J.R. Paterson, "The Development of Elastomeric Insulating Materials For Use Under Extreme Service Conditions," Fifth International Conference on Dielectric Materials, Measurements and Applications (Canterbury, UK June 27-30 1988), pp. 143-146.

This technical piece discusses how to use a thermal imager to conduct predictive maintenance on insulation systems in high temperature environments. After testing insulating material in a severe heat environment, imagers and spectrometers were used to monitor the composition and gases given off from the insulation to test for toxic materials could harm users of the company's insulating equipment. The authors mention that much proprietary information has been withheld by manufacturers.

Warren, L. and J.R. Paterson, "The Use of Thermal Imaging for the Development of Materials to Withstand Extreme Service Conditions," Fifth International Conference on Dielectric Materials, Measurements, and Applications (Canterbury, UK June 27-30 1988), pp. 1290-1292.

This piece is very similar to the other from Warren and Peterson. The authors propose exposing polymeric materials to extreme testing conditions of heat, then analyzing them by thermal imaging to test for hot, weak spots which will lead to degradation and breakdown of the materials.

Watanabe, T. et. al., "Radiation Thermometry of Silicon Wafers in a Diffusion Furnace for Fabrication of LSI," IEEE Transactions on Semiconductor Manufacturing (February 1991), pp. 59-63.

Discusses a novel technique in which thermal imagers are used to measure the temperature of silicon wafers in a diffusion furnace in production. This experimental technique is very important because as annealing (cooling) time decreases in silicon wafer production (a desirable trait to increase productivity), monitoring sensitive temperature variations becomes very important.

Welch, C.S., "Material Property Measurements with Post-Processed Thermal Image Data," SPIE Conference on Thermosense XII (April 1990) pp. 124-132.

Proposes method for data processing to find defects in materials.

Yonushonis, T.M., et. al., "Infrared Thermal Wave Imaging of Thermal Barrier Coatings for Diesel Applications," American Ceramic Society Bulletin (August 1992) 9 pgs.

A rapid non-destructive evaluation technique has been developed for rapid inspection of coatings. Processing parameters can be improved without requiring expensive, time-consuming engine tests, thereby

significantly improving productivity and performance.

Zuech, N., "Improve Product Reliability with Thermal Imaging," Test & Measurement World (October 1990) pp. 73-81.

Infrared detectors can be used to assess electronics, and most significantly integrated circuit boards, at several stages of production: bare-printed circuit boards, damaged circuit cards, or prototypes.

#### **(vi) Applications of IR Sensitive Materials in Preventive Maintenance**

Ayers, W.A., "Nonintrusive Infrared Testing of High-Voltage Switchgear," Materials Evaluation (May 1991) 3 pgs. Contends that IR thermography could be used to inspect far more electrical components in plants, and therefore be even more valuable, but quality control engineers are afraid of getting closer to high-voltage components which should be inspected. IR inspection, of course, is the most remote way to inspect those components.

Baird, G.S., and R.T. Mack, "ASNT Thermographic Certification Update," SPIE Thermosense XIV Conference (April 1992) pp.98-99.

Black, J.E., Jr., "Utility Gain Through Infrared Predictive Maintenance," SPIE13 pp. 34-40.  
A case study of Toledo Edison Co.

Bryson, F.G., "Rational Approach to Nuclear Power Station IR Surveys," SPIE Thermosense XII (April 1990) pp. 64-71.

Dickey, J.W. and B.R. Schulthorpe, "Predictive Maintenance Practices at FPL," Nuclear News (December 1992), pp. 64-67.  
The Florida Power & Light Co. has made significant improvements in its ability to identify existing or potential problem areas using predictive maintenance methodologies. These methods allow the utility to determine not only what work has to be scheduled, but also what work does not have to be performed, during plant outages. Thermography has been used to identify such things as high-resistance electrical connections, overloaded distribution circuits, boiler insulation degradation, blocked cooling passages, overheating bearing, shorted motor windings, etc. The article emphasizes the money savings from investing in thermography maintenance.

Edgley, Kip, "Infrared Scanning Improves Preventive Maintenance on Equipment Used for Water and Wastewater Treatment," P/PM Technology (1991) p.21.  
Infrared thermography is particularly important in electrical preventive maintenance. Loose, dirty, corroded, or oxidized electrical contacts and connections produce heat proportional to the power dissipation. Thermographic scans identify and measure the temperature gain of heat related anomalies in electrical equipment. Because it surveys from a distance, it makes possible the inspection of otherwise inaccessible components.

Edgley, K. "Infrared Scanning Improves Preventive Maintenance," Water: Engineering & Management (March 1991) pp. 38-41.  
Explains to utility and economic sense of periodic scheduled thermographic inspections, and applies it directly to wastewater facility machinery and electrical equipment.

Fallon, Mary D. and Andrew C. Teich., "Role of Infrared in Plant PDM," Plant Services (October 1991), 3 pgs.

Discusses how infrared thermography is emerging as one of the most diversely applicable and effective predictive maintenance diagnostic tools available today. The reason for imaging the heat distribution in moving parts is that mechanical or rotating equipment produces excessive heat when corrosion build-up occurs or when it is not properly lubricated or aligned. Abnormal heat in electrical equipment is often the result of loose connections and overloaded circuits. This is a very important article which discusses the widespread applications of thermography to maintenance.

Feit, E., "Infrared Inspection Saves Time & Money," Forest Industries (February 1986) pp. 10-11.

Describes how wood industry could benefit from thermographic inspections. Case studies. The earliest article we found on thermographic PM.

Garner, J.M., "Infrared Research Services vs. SSS: The Bottom Line," SPIE Thermosense XIV Conference (April 1992), pp. 23-29.

Case studies of how thermographic inspection as part of a preventive maintenance regime has saved companies money. Article investigates the positive savings when recommendations were implemented and the cost attributed to recommendations ignored.

Graf, R.J. and G.J. Weil, "Steel Plant Predictive Maintenance Programs Utilizing IR NDT," SPIE Thermosense XII (April 1990) pp. 47-52.

Another case study of IR used in PM.

Green, T.R., "Preventive Maintenance Program Ensures System Reliability," Transmissions & Distribution (April 1991) pp. 52-54.

Case study of Baltimore Gas & Electric, which uses thermography to inspect all its overhead power lines.

Grover, P., "Applying ANSI/IEEE/NEMA Temperature Standards to Infrared Inspections," SPIE Thermosense XIV Conference (April 1992) pp.101-107.

Discusses the temperature standards which are fundamental to thermographic inspection. Proposes an alternated method for prioritizing potential problems with overheating equipment, which is referenced to nationally-recognized electrical equipment temp standards which are adjusted to account for ambient temperature and load differences.

Hurley, T.L., "Infrared Qualitative and Quantitative Inspections for Electric Utilities," SPIE Thermosense XII (April 1990) pp. 6-24.

Infraspection Institute Newsletter, Published quarterly by Infraspection Institute.

Johnson, P.F., "Is It Worth It? -- Statistics of Corporate-based IR Program Results," SPIE Thermosense XIII Conference (April 1991) pp. 47-50.

Using statistics, authors at American Risk Management Corp. persuade industry that substantial savings can be found to companies that implement IR regimes.

Kaplan, H. "IR Monitoring Makes Nuclear Plants Safer," Photonics Spectra (December 1990) pp.74-76.

Describes how nuclear power industry has grown, by necessity, to utilize thermographic inspection more thoroughly than any other one.

Kaplan, Herbert, "Photonics at Work," Photonics Spectra (September 1988), pp. 70-72.

Infrared nondestructive testing (IRNDT) of laminar materials is based on the facts that a good thermal bond is a good structural bond, and that voids, unbonds and foreign matter affect the flow of thermal energy

across (normal to) the laminar layer. The thermal injection approach requires the generation of a controlled flow of thermal energy across the laminar structure of the sample material under test, thermographic monitoring of one of the surfaces (or sometimes both) of the sample, and the search for anomalies in the thermal patterns so produced that will indicate a defect in accordance with established accept-reject criteria. The author reviews the mechanisms used for generation and injection of thermal energy into test samples, and the typical failure modes.

Kaplan, Herbert, "What's New in IR Thermal Imagers," Photonics Spectra (February 1991), pp. 86-88.

A short article describing several new thermal imaging models on the market, and the trends which make them more "user friendly" and therefore more likely to gain a wide audience among manufacturing engineers and non-destructive testing managers. The trends are: portability, uncooled FPA's (vastly reducing cost), and better liquid-crystal displays.

Leftwich, R., "Multi-Detector Thermal Imagers," (Magnavox Government and Industrial Electronics Company: 1989), 10 pgs.

An overview and comparison was given of the most commonly used TV-compatible systems employing parallel and serial scanners. Also described were a variety of image processing techniques for image enhancement and operator aids.

Lucier, Ronald D., "Using Infrared Thermography in Nuclear Power Generating Stations" Nuclear Plant Journal (May-June 1989), pp. 1-4.

Infrared scanning, as part of a preventive maintenance program, can isolate and or detect problems before costly failures occur. The article considers infrared as a thermal performance tool, in particular: image recording, temperature resolution, image interpretation, some infrared applications in nuclear facilities, are discussed, e.g. checking of electrical systems safety equipment, and insulation. Some new application examples are described. Computerization of infrared thermography and differential thermography are cited among new developments. Kittson, J.E., "Department of National Defence's Use of Thermography for Facilities Maintenance," SPIE

Thermosense XII Conference (April 1990) pp. 2-5

Lucier, R.D., "Essential Elements and Goals for an Infrared Predictive Maintenance Expert System," SPIE Thermosense XV Conference (April 1993) Paper 1933-05.

Discusses how to implement a thermographic PM regime.

Lucier, R.D., "Predictive Maintenance for the 90's: An Overview," SPIE Thermosense XIV Conference (April 1992) pp. 35-42.

Predicts that machines designed for preventive maintenance will be two-dimensional staring arrays with radiometric qualities.

Lucier, R.D. and H.L. Kaplan, Infrared Thermography Guide, (Electrical Power Research Institute: Palo Alto, CA) September 1990.

A how-to guide for thermographers, listing equipment to check and procedures.

MacDavid, J.H., "Buried Steam-Line Temperature and Heat Loss Calculation," SPIE Thermosense XIII Conference (April 1991) pp. 2-10.

MacNamara, N.A. and A.E. Hammett., "Development of a Comprehensive IR Inspection Program at a Large Commercial Nuclear Utility," SPIE Thermosense XIV Conference (April 1992) pp.30-34.

This paper describes the development of an integrated infrared program within a nuclear operating company

from the early conceptual stages to the beginnings of a workable end product.

Madrid, Angel, "Using IR Thermography for Quantifying Failure Rates of Electric Power Network Components," Conference on Infrared Technology XVI; Proceedings of the SPIE (July 11-13 1990), pp. 24-45.

A technique based on IR thermography measurements is proposed to estimate realistic values of electric hardware failure rates corresponding to secondary failures; that is, those caused by past or present out-of-tolerance or abnormal operating conditions. The technique allows the establishment of useful correlations between these failure rates, and the corresponding relevant thermal patterns as mapped using IR thermography. The technique is applied to practical cases of secondary failures in typical AC and DC electric power network components having to do with failure modes due to abnormal stress, corrosion, and erosion. The applications of this technique to fault and failure diagnosis, and both reliability, availability, and maintainability analysis and probabilistic risk assessment of electric power networks is also briefly discussed.

Moy, R.Q. R. Vargas, and C. Eubanks "Predicting Electronic Component Lifetime Using Thermography," SPIE Thermosense XIII Conference (April 1991) pp.154-160.

Researchers are at IIT Research Institute and Aerospace Guidance and Metrology Center.

Nuclear Maintenance Applications Center, Infrared Thermography Guide, Final Report, NP-6973, July 1990, Research Project 2814-18.

Paxton, Clint, et. al., "Infrared-Thermographic Inspection Improves Service Reliability," Transmission & Distribution (April 1992), 4 pgs.

A non-technical article on how Pacific Gas and Electric Co. is meeting the goal of improved service reliability while cutting some of the expense associated with outages with better maintenance, construction practices, purchasing state-of-the-art equipment and providing more technical training for employees by using infrared thermography in field-inspection programs. Discusses the basics of thermography theory, inspection strategy, and hardware/personnel requirements.

Ridley, W.C., "Integrating Thermography into the Palisades Nuclear Plant's Electrical Predictive Maintenance Program," SPIE Thermosense XIII Conference (April 1991) pp. 51-58.

Author, at Consumer's Power Company, contends that integration of IR into existing PM techniques at this nuclear power plant was very successful.

Sharma, Y.P., "Nondestructive Inspection of Surface Mount Compounds," Surface Mount Technology (April 1989), pp. 11-14.

High density packaging and interconnection technologies have led to the miniaturization of surface mounted components to such a degree that even routine optical inspections are not adequate to detect defects in components. It is reported that nondestructive techniques are available for inspecting individual components prior to, during, and after their assembly on the board. The nondestructive techniques such as infrared thermal imaging, ultrasonics, and X-ray radiography are useful for detecting potentially defective components from nondefective ones, although the use of ultrasonics requires immersing parts in a fluid for proper acoustic coupling.

Slizewski, L.S., "The Role of Infrared Surveys in Loss Prevention," AIPE Facilities (January/February 1992) 3pp. Technical piece intended to give electrical plant quality control engineers a closer look at thermographic inspection. Contends that thermography has proven its worth as a loss-prevention tool. Includes survey information on how much money could be saved through routine thermographic inspection.

Snell, J.R., "Energy Management Technology Report: A Maintenance Strategy You Can't Afford to Be Without," Engineer's Digest (January 1989) 4 pgs.

IR consultant-author offers several case studies of customers who have saved several times the start-up and consultant costs after getting thermographic inspections of their plant's electrical equipment, mechanical equipment, roofs, etc.

Snell, J.R., "Developing Operational Protocol for Thermographic Inspection Programs," SPIE Thermosense XIV Conference (April 1992) pp. 12-22

An article intended for thermographers, discussing all the factors which contribute to effective and credible thermographic inspections of equipment.

Snell, J.R., "Infrared Thermography: Answers to Questions You've Wanted to Ask," Maintenance Technology (June 1992) 6 pgs.

Introduction to IR thermography for plant equipment maintenance engineers.

Snell, J.R., "Infrared Video Camera Improves Equipment Maintenance at Champion International," P/PM Technology (May/June 1989) pp.12-13.

Another case study which discusses the cost savings to a company which signed up with the consultant (author).

Snell, J.R., "Integration of Infrared Testing into Various Maintenance Philosophies," SPIE Thermosense XV Conference (Paper 1933-02).

Discusses IR thermography's contributions in conjunction with oil analysis, vibration analysis, etc.

Snell, J.R., and R.W. Spring, "Surveying the Elements of Successful Infrared Predictive Maintenance Programs," SPIE Thermosense XIII Conference (August 1991).

Good background on all factors involved in good thermographic inspections, not just equipment.

Snell, J.R., "Thermographic Inspection of Plant Electrical Systems," Maintenance Technology (May 1990) 4pgs.

Intended to introduce plant maintenance engineers with how thermographic inspections are conducted, what the thermographer is looking for, and what the electrical plant will get out of the inspection.

Stern, S.A., "Infrared Thermography IMaging System Multiapplications for Manufacturing," SPIE Thermosense XII (April 1990) pp. 53-63.

Teich, Andrew C., "A Cool Box Finds Hot Spots," Photonics Spectra (August 1991), p. 9.

Inframetrics, a leading industrial process IR system producer, has integrated all the necessary imaging and analysis hardware in a portable rig which can be used for failure detection. It is representative of the leading units in the field. The system can image samples from -20 to 1500 degrees celsius, with an accuracy of +/- 2 degrees.

Teich, Andrew C., "Predictive Maintenance with Thermography," Promotional Piece from Inframetrics, Inc. Billerica, MA, 5 pgs.

An extremely broad overview of the utility of thermography in detecting problem areas in early stages of deterioration, thereby saving companies vast amount of money. This is just a summary piece of the other, more detailed articles written by Teich.

Tomlinson, P.D., "Predictive Maintenance: Key to an Effective, Cost-Saving maintenance Program," Complete Building Equipment Maintenance Desk Book, S.J. Fuchs (ed), pp. 39-65 (Prentice-Hall, Englewood, NJ)



1982.

Weil, G.J., "Steel Plant Maintenance Programs Utilizing IR NDT," SPIE Thermosense XII Conference (April 1990) pp. 47-51.

Discusses how IR thermography can be used specifically in the steel industry. Discusses the cost benefits of thermography as it applies uniquely to steel plants, and recommends specific inspection regimes.

Wurzbach, R.N., "Increasing Maintainability and Operability of Emergency Diesel Generators with Thermographic Inspections," SPIE Thermosense XV Conference (April 1993) Paper 1933-03)  
Another specific case study.

Wurzbach, R.N., "Thermographic Monitoring of Lubricated Couplings," SPIE Thermosense XIII Conference (April 1991) pp. 41-46.  
Case study of Philadelphia Electric Co.

Wurzbach, R.N. and R.G. Hammaker, "The Role of Comparative and Qualitative Thermography in Predictive Maintenance," SPIE Thermosense XIV Conference (April 1992) pp. 3-11.  
Compares both techniques for preventive maintenance, concluding that although quantitative thermography is more difficult technically, it will gain more widespread appeal.

#### **(vii) Applications of IR Sensitive Materials in Process Control**

Ahlstrom, J., "Review of Industrial and Research Applications of Thermography," (SPIE Paper 1320-21), 1990, 4 pgs.  
An all-applications, no-technologies discussion of thermography, which gives a good overview of the applications for which IRFPA will be competing if costs can be brought down. These are certainly low-end of the market niches, but it is a good overview piece nonetheless.

Anderson, C.J., "Automated Infrared Scanning in Cray Y-MP Production," SPIE Thermosense XII (April 1990) pp. 207-217.

Back, B., "Adaptive Welding Increases Quality," Photonics Spectra (January 1991) pp. 181-185.  
For high-quality welds, it is critical that joints be precisely positioned. The usual way of automating welding processes has been to install arc-welding robots, who work according to a program that specified weld path, torch angles, welding parameters, etc. To assure faster, more consistent and higher quality welds, the authors developed a system which uses an infrared sensor to view the weld.

Balle, M., "Automated IR-Weld Seam Control" SPIE Thermosense XII (April 1990) pp. 332-339.

Banerjee, P. and B.A. Chin, "Gradient Technique for Dynamic Bead Width Control in Robotic Gas Tungsten Arc Welding," Conference on Recent Trends in Welding Science & Technology (June 1-5, 1992) 5 pgs.  
A novel approach for the in-process detection and control of bead width is presented. An infrared sensor is used to acquire thermal distributions on the welded surface during the gas tungsten arc welding process. In order to monitor weld bead width, these distributions were analyzed in-process.

Banerjee, P., and B.A. Chin, "Infrared-Sensor Based On-Line Weld Penetration Control," SPIE Thermosense XV Conference (April 1993) Paper 1933-12.

Banerjee, P., J. Liu, B.A. Chin, "Infrared Thermography for Non-Destructive Monitoring of Weld Penetration Variations," Proceedings of the Japan USA Symposium on Flexible Automation (American Society of Mechanical Engineers, 1992) pp. 291-295.

The thermal distributions obtained during the gas tungsten arc welding process were analyzed using mathematical techniques to determine if changes in the surface temperature distribution could be correlated with changes in weld penetration. An infrared scanning camera was used to obtain the temperature profiles.

Banerjee, P., Nagarajan, S. and B.A. Chin, "Weld Quality Control in Gas Tungsten Arc Welding Process," Proceedings of NSF Design and Manufacturing Systems Conference (1991), pp. 143-47.

An infrared sensor was used to control the quality of welds produced during gas tungsten arc welding process. Among the weld parameters, penetration depth and position of the weld pool were investigated. Temperature distributions in the vicinity of the weld pool were measured using the infrared sensor. These measure temperature distributions were analyzed to determine penetration depth in real-time. The position of the weld pool was controlled using the asymmetry in temperature distributions. The ability of infrared sensor to monitor more than one weld process parameter was also demonstrated. As an example, weld pool offset and width were simultaneously identified.

Banges, Edmund R. and Erland Jungert, Artificial Intelligence in the Development of Adaptive Control for Fusion Welding (SME, 1986), 18 pgs.

The ability to control fusion welding processes in an adaptive control mode and perform an inspection in real time is of interest to fabricators in the pressure vessel, aerospace, and shipbuilding industries. This paper presents a series of experiments using infrared thermography as the principal sensing mode to study artificial intelligence contained in weld puddle isotherms. The information obtained may prove valuable in the control of the welding process. Image processing computer software development was initiated in the development of algorithms that correlate geometric shape change data to changes in the critical process and procedure variables. The IR vision sensor generates a partial Raster image which is analyzed by the image processing system. Decision support for preservation of weld quality is made by an expert system.

Bangs, E., "IR Monitors Cutting-Tool Wear," Photonics Spectra (November 1991) pp. 22-23.

Millions of dollars are lost each year in the metal-removal industry in the scrapping of machined parts as a result of worn cutting tools. Research metallurgists report that the increased heat generated as a result of tool wear is readily detectable by the infrared camera. Infrared Monitoring Systems has designed a thermographic screening machine using commercially available infrared cameras to test a tool for wear.

Bettelheim, J. and P.G. Williams, "Research and Development and Its Contribution to Improvement in Coal-Fired Plant Performance," Power Engineering Journal (September 1988), pp. 253-258.

The authors explain the ways in which their company, CEGB, is pursuing technologies, some of them infrared, to optimize coal-fired power plant performance. Among the techniques they have developed are flame monitoring which presently only uses two points on the flame (IRFPAs would vastly improve this technique) and sonic pyrometry to measure the furnace temperatures. Although not addressing IRFPAs directly, these two monitoring techniques could vastly benefit from IR arrays.

Bomse, D.S., et. al., Optically Based Methods for Process Analysis, (SPIE: March 1992) 40pgs.

The proceedings focuses on in-process analytical instrumentation used in spectroscopy, process control color measurement, and product quality measurement in industrial production environments including pharmaceutical, petrochemical, and chemical manufacturing. The papers are multidisciplinary, being contributed from scientists and engineers involved with research, plant design, process quality control, and environmental monitoring. Bickell, A., "NIR: Earning a Place in Process Control," Quality (May 1990) pp. 56-58.

Near infrared spectroscopy is being used in the process industries, such as petroleum, chemicals, polymers, textiles, pharmaceuticals, films, coatings, foods, and adhesives. Article gives several case studies and explains how other industries can stand to benefit from NIR spectroscopy.

Burkell, R., and J. Murphy, "Infrared Imaging Systems Automate Aircraft Engine Inspection at General Electric," Integrated Engineering (April 1989) pp. 28-32.

Describes how GE thermally inspects components of its aircraft engines, specifically turbine blades which have had internal passages and surface cooling holes drilled. IR confirms that heat does circulate through those cooling passages.

Chin, B.A., Goodling, J.S. and N.H. Madsen, Infrared Thermography Shows Promise for Sensors in Robotic Welding (SME: 1983), 3 pgs.

Infrared thermography shows promise as a means of sensing errors in arc position, seam variations, and presence of contaminants in the weld path. The experiments were performed with various types of sensors (acoustic, infrared thermography, optical and on-line radiography), all categorized as direct sensors.

Chin, B.A. and N.H. Madsen, Infrared Sensors for Welding Process Control: Advanced Systems for Manufacturing (SME: 1985), 10 pgs.

The objective of the research is the development of closed-loop controlled welding using infrared sensors. The primary benefit of the research would be an increase in the number of welding situations that can be automated. This is a preliminary article to the 1991 one published by Banerjee.

Coughlan, J., "Melt-temperature Detection Problems You May Not Know You Have," Modern Plastics (April 1992) pp. 101-105.

Current systems for critical temperature measurement in plastics are outdated, relying on inadequate and insufficient temperature information. Precision melt-temperature control, using infrared temperature sensors, is a new technology which performs much better than all other existing techniques.

Curran, R.L. and Ihab H. Farag, "Radiation Pyrometry of Glass During The Container Forming Process," IEEE Transaction Papers (Date Unknown), pp. 1092-1097.

Radiation pyrometry is an ideal form of non-destructive testing to measure the thermal profile of glass containers during a variety of different processes. Glass production is an ideal field to employ thermal imagers because a few degree change in glass temperature can change glass viscosity by a factor of 10, significantly affecting the molding process. The authors propose that thermometry will work well in glass molding.

Curran, R.L., I.H. Farag, "Radiation Pyrometry of Glass During the Container Forming Process," IEEE Transactions (Paper #88CH2565-0, 1988) pp. 1092-1098.

Technical how-to piece on use of non-contact temperature profiling used during the forming of glass containers by a variety of different processes.

D'Agostino, S., "1991 Trends: Imaging: Application Know-How Drives Success," Photonics Spectra (January 1991) pp. 131-132.

Discusses the future of machine vision. Predicts that the price/performance ratio of machine vision systems will continue to improve. Whole systems could sell for <\$10,000.

D'Amato, D.P., et al., Machine Vision Applications in Character Recognition and Industrial Inspection (SPIE: WA) February 1992.

There is a race to make better, smaller, faster, and less power consuming microelectronic devices, and machine vision is a technology whose time in the microelectronics manufacturing world has arrived.

Danaher, Hugh, "Thermography: Understanding the Expanded Role of Thermal Imagers in Production," Evaluation Engineering (December 1988), pp. 77-79.

Thermal imagers quantitatively and qualitatively evaluate designs, determine proper operating conditions and facilitate repair of electronics components, subassemblies and final assemblies. Thermographic and other electronic instruments rely on quantitative data to determine conformance to specification and functionality of a device-under-test. The type of data they use to draw these conclusions is irrelevant. Only the accuracy and efficiency of obtaining meaningful results matter. When considering both of these criteria, thermal imagers often are perfect adjuncts to functional and inter-circuit testers to provide the most cost-effective solution.

Deeley, E.M. and P. Kontopoulous, "Strip speed measurement using distributed infrared detectors," IEEE Proceedings, Part D (July 1991) pp. 395-399.

A non-contact method for measuring the speed of electrically conducting strip over the range of speeds found in industry is described. The method is thermal in character and relies on the ability of hot strip to store heat for short periods of time. A wavelength-sensitive reading head consisting of an array of equally spaced infrared detectors senses the heat pattern present on the moving strip. The signals from the array elements are combined and the array acts as a spatial filter. The resultant signal is then fed back to a checker, or writing head, placed upstream of the reading head, resulting in a closed loop time delay feedback systems which oscillates at a frequency proportional to the strip speed. Phase shifts within the feedback loop cause a departure from linearity in the speed/frequency relationship. This effect is minimised by a digital feedback loop. Use of high-performance detectors would enhance performance, particularly for low-emissivity material.

Fike, D.K., "Using Infrared Thermography as a Manufacturing Tool to Analyze and Repair Defects in Printed Circuit Boards," SPIE Thermosense XIII Conference (April 1991) pp. 150-153.

Author, at IBM corporation, explains their research into using IRFPA-based systems.

Fuchs, E.A., et. al., "Thermal Diagnostics for Monitoring Welding Parameters in Real Time," SPIE Thermosense XIII Conference (April 1991) pp. 136-149.

Gauvin, Jacqueline, "Technology Update," Robotics Today (January 1986), p. 12.

A NSF Grant will support a study of robot positioning accuracy that will use acoustic methods to measure position. A remote maintenance robot has been developed to perform maintenance tasks on the Sandia Pulse Nuclear Reactor III in New Mexico. A Study by Frost and Sullivan (New York) predicts the market for industrial vision systems will increase to \$980 million dollars in sales by 1999 at a mean annual growth rate of 57%. An infrared charged-coupled device camera developed by RCA (Moorestown, NY) can sense slight amounts of heat, allowing the unit to "see" vehicles, observe personnel movements, track heat-emitting objects, or provide topographical data. Integrated sensor technology is being used at the University of Pennsylvania to produce microsensors small enough to allow as many as 250 sensors to fit on a single silicon chip.

Giacobbe, F.W., "Selective Hardening of High Carbon Steel Using an Argon Thermal Plasma Flame," IEEE Conference on Plasma Science (May 1989), p. 117.

Thermal sensors were used in the selective hardening of high carbon steel using an argon thermal plasma flame. While continually rotating the samples, they were rapidly heated to 870 degrees celsius, kept there for 1 minute, and then cooled. Although the approach in the article is metallurgical, it also signals a

potential use for IR technology. Gilblom, D.L., "TDI Solves Web-Inspection Problems," Photonics Spectra (May 1991) pp. 189-192.

Govardhan, S.M. and B.A. Chin, "Adaptive Penetration Control Using Infrared Measured Temperature Gradients," SPIE Thermosense XV Conference (April 1993) Paper 1933-13.

Graeve, T., E.L. Dereniak, and J.A. Lamonica, "An Improved Infrared Technique for Sorting Pecans," Rev. Sci Instrum. (October 1991) pp. 2476-2479.

Presents the results of a study of pecan spectral reflectances. Describes an experiment for measuring the contrast between several components of raw pecan product to be sorted. It is believed that this technique has the potential to dramatically improve the efficiency of current sorting machinery, and to reduce the cost of processing pecans for the consumer market.

Gring, W., "It's Either Hot. or it's Not: Infrared Technology Speeds up Power Inspections at US West COs in Arizona and New Mexico," Telephony (July 27, 1992) pp. 22-24.

Case study of immense financial benefits to companies which began using sophisticated IR cameras to scan power lines. Goes through the mechanics of inspections.

Guerrieri, M., Infrared Temperature Sensing (SME: 1987), 8 pgs.

To improve the manufacturing process in both productivity and quality, precise data must be gathered on the variables that affect production. Temperature plays a critical role at vital points in most manufacturing processes. Processing temperatures are a measure of resultant quality in metals, plastics, chemical and food processing, as well as paper making, printing, and numerous other processes. Infrared noncontact temperature sensors provide a method of gathering significant information on temperature and, when coupled with data processing electronics, can be a vital element in an automated process or manufacturing line. This paper covers recent advances in infrared thermometers and applications in which they have made major contributions in quality and/or productivity.

Guerrieri, Matt, State of the Art in Infrared Temperature Sensors (SME: 1986), 8 pgs.

Noncontact infrared thermometers are aiding engineers to achieve enhanced productivity and improved quality control in manufacturing processes. In virtually any process in which temperature is a significant factor, IR thermometers can provide precise heat measurement, resulting in greater yield and consistency of product. Improvements in IR sensor components, accompanied by significant price declines for the instruments, have made possible price and performance that matches almost every heat sensing requirement.

Haugh, M.J., D.P. Stone, M. Thangavelus, "Paint Skip Detector," SPIE Thermosense XII (April 1990) pp. 190-199.

Holmsten, D. and R. Houis, "High-Resolution Thermal Scanning for Hot-Strip Mills," SPIE Thermosense XII (April 1990) pp. 322-331.

Hospod, T., "MV Soft- and Hardware Integration -- A Practical Approach," Photonics Spectra (February 1991) pp. 177-183.

An introduction to machine vision: discusses both machine guidance and automated inspection, common requirements, processing-hardware selection, and camera selection. A good overview article, which does not specifically address infrared detectors.

Hyvarinen, Timo, et al., "Infrared Analyzers for Process Measurements." Unpublished Paper (1992) 6 pgs.

Optical analysis techniques, infrared spectroscopy in the front end, are rapidly achieving new applications in process control. This progress is accelerated by the development of more rugged instrument

constructions. This paper discusses two analyzer techniques especially developed for use in demanding environments: the integrated multichannel detector technique, and a miniaturized Fourier transform infrared spectrometer. The future holds more detector array style sensors rather than the singular photovoltaic sensors presently in use. This will make it possible to monitor the human body, the food we eat, and the environment we live in (ie. the authors simplified the possible applications)

Jenks, Nigel, "Transverse Temperature Measurement to Improve Hot Strip Quality," Steel Times (May 1989), pp. 242-44.

Accurate temperature measurement has a role to play in all modern hot strip mills in helping to achieve consistency of material properties. Infra-red scanning cameras enable hot band temperature profiles to be measured across the width and along the length of the hot band. Information on the complete temperature profile, instead of just the center line temperature as recorded by a pyrometer, enables accurate control measures to be implemented to maintain uniform properties.

Kaplan, Herbert, "Applications Unlimited: Innovations Spur Productivity," Photonics Spectra (September 1991), pp. 79-89.

Kaplan discusses how photonic systems are assuring quality in non-destructive testing in real time, often in automated assembly-lines. He emphasizes the linear CCD (Charge-Coupled Displays) camera, which will employ IRFPAs as soon as the technology becomes affordable. Although not a head-on articles for IRFPAs, it introduces photonics in industrial sensors well.

Kaplan, H., "Innovations Spur Productivity," Photonics Spectra (September 1991) pp. 79-89.

Outlines four new automated industrial applications for photonic technologies which are representative of the areas in which machine inspection technologies are penetrating the market. One application discussed, in which solders on a PC board are monitored, uses infrared detectors.

Kaplan, H., "Laser-Beam Diagnostics with Pyroelectric Cameras," Photonics Spectra (December 1992) pp. 64-65.

Pyroelectric cameras can uniquely image over a broad spectrum, from ultraviolets to far-infrared. In the 1-25 micron region, the cameras could perform beam detection, beam alignment, and beam-dispersion analysis, since most lasers operate at those wavelengths.

LeBeau, C.J., "Machine Vision Drives Quality to New Highs," Photonics Spectra (September 1991) pp. 122-126. Describes how Motorola is integrating machine vision, some infrared, into its semiconductor manufacturing processes from the early states of wafer fabrication to the final stages of outgoing package inspection.

Lin, T.T., J.S. Goodling, and K. Groom, Adaptive Welding Using Infrared Sensing Techniques: Manufacturing Processes, Machines, and Systems (SME: 1986), 8 pgs.

This appears to be an intermediate article between the preliminary sensors-in-the-welding-process study by Madsen in 1985, and the final results published by Banerjee in 1991. The research investigates the feasibility of using infrared sensors to monitor the welding process. An infrared camera was trained on the molten metal pool during the welding operation. Several types of process perturbations which result in weld defects were then intentionally induced and the resulting thermal images monitored. Gas tungsten arc using AC and DC currents and gas metal arc welding processes were investigated using steel, aluminum, and stainless steel plate materials. The thermal images obtained in the three materials and different welding processes revealed nearly identical patterns for the same induced process perturbation. Based upon these results, infrared thermography is a method which may be applicable to automation of the welding process.

Linnander, B., "James River Uses Infrared Scanner to Investigate Off-Spec Production," Pulp & Paper (November

1992) pp. 131-132.

Case study of a paper mill which uses sophisticated infrared cameras to troubleshoot when paper quality falters. Discusses the benefits of permanent, linear arrays which image rapidly and are placed in several locations along the paper production web.

Mathews, Thomas R., Application of Sensors in an Untended Forging Cell: A Case History (SME: 1986), 9 pgs. Sensors are important to the successful operation of any untended manufacturing process. This paper examines how sensors are integrated in the design of a turbine blade preform forging manufacturing cell. A wide range of sensors, including vision gaging, gas analyzers, infrared temperature measurements, other temperature transducers, pressure transducers and others are required to achieve untended operation of the cell. Also discusses the problems, solutions, and future requirements.

McWalter, K., "Machine Vision on Today's High-Tech Factory Floor," Photonics Spectra (September 1991) pp. 97-100.

Discusses the advent of widespread machine vision, the mechanics of actually integrating cameras into assembly processes, the integration process, the benefits once a system is installed, and new industries in which inspection equipment is becoming available. Article is not strictly IR. A good overview of direction of machine vision market and machinery.

"Microelectronics Spurs Measurement Market," Photonics Spectra (January 1992) p. 118.

As a result of higher integrated circuit densities and pressure for low-cost, high-throughput quality control, the demand in the microelectronics industry for electro-optic test, measurement and inspection (TMI) equipment will continue to grow. This market, \$582.4 million in 1989, is forecast to reach \$1.4 billion by 1996, according to Market Intelligence Research Corp. (MIRC).

Nagarajan, Sundaram, et. al., "Control of the Welding Process Using Infrared Sensors," IEEE Transactions on Robotics and Automation (February 1992), pp. 86-93.

Preliminary results from the use of sensors in a welding system suggest that simultaneous penetration depth, bead width, and torch position control are possible using a single IR camera. The camera, produced by Inframetrics, was in the 8-12 micron range, and gave a matrix of 250 x 192 discrete temperature measurements. The experiment showed that IR sensors can indeed be successfully used to control the welding process. This is a good piece on IR research in metallurgy welding.

Nagarajan, S., W.H. Chen, B.A. Chin, "Infrared Sensing for Adaptive Arc Welding," Welding Research Supplement (November 1989) pp. 462-466.

Adaptive welding enables dynamic altering of the welding parameters to compensate for changing environment. Sensors providing process status information in real time are integral to an adaptive system. In this investigation, IR thermography was used as a sensor to control the position of the arc and the penetration depth of the weld. Preliminary work on IR thermography showed that variation in these parameters produces a change in the surface temperature distributions of the plates being welded. Subsequently, to achieve computer control of these variables, image analysis techniques were developed to quantify the changes in the temperature distribution.

Nagarajan, S., H.C. Wickle III, B.A. Chin, "On-Line Weld Position Control for Fusion Reactor Welding," Journal of Nuclear Materials (Paper 0022-3115, 1992) pp. 1060-1064.

Infrared sensing techniques were investigated to assist remote welding systems to identify and correct weld-joint offsets in real time. During the welding process, the temperature distribution along a line of normal to the joint and ahead of the arc was measured, using an IR detector.

O'Connor, L., "Smart Sensors Ride the Rails," Mechanical Engineering (December 1991) pp. 54-55.

Costly and dangerous freight car derailments that occur when roller bearings heat up rapidly have prompted the development of new sensor based systems to avert the danger. Infrared temperature sensors are one solution.

"Optical Spectrometry," Chemical and Engineering News (March 18, 1991), pp. 46-55.

An overview of the optical spectrometers shown at their annual instrumentation trade show. The trends were sharper detection levels, portability, and an accent on designing for specific applications. This will be a good market manufacturer survey if we identify spectrometry as an important future area of IRFPA use.

Orlove, G.L., "Development of a Radiometric Model for the Detection of Plastic Coating Omissions on Aluminum Substrate," SPIE12 pp. 184-189.

O'Shaughnessy, S., "Machine Vision Catches Problems Early On," Photonics Spectra (December 1990) pp. 80-81.

Discusses several industries which are using state-of-the-art machine vision which uses a complete control strategy to implement a statistical process control system.

Paxton, C., "Infrared Thermographic Inspection Improves Service Reliability," Transmission & Distribution (April 1992) pp. 32-35.

Another electrical utility describes the economic benefits of thermographically inspecting its power lines.

Rabie, Abdelrahman, The Use of Sensors in Part Handling (SME: 1983), 12 pgs.

Although old, this article discusses an important IR technology. Two laboratory techniques for part handling implement two different types of noncontact proximity light sensors. One technique used photo-resistive cells for part orientation while the other used IR sensors for part detection. Both the hardware and the software are fully explained as are the major limitations of each technique.

Raghavan, S., H.C. Wilke, B.A. Chin, "Adaptive Control of Submerged Arc Welding Using Infrared Sensing," SPIE Thermosense XV Conference (April 1993) Paper 1933-11.

Rogers, J.K., "Gaging Systems Lead March to Quality," Modern Plastics (November 1992) pp. 54-56.

Discusses, among other technologies infrared gages, which are used in industry where on-line compositional analysis is necessary, such as in determining the amount of barrier material in a multilayer extrusion, or measuring the amount of polymer on a foil or paper substrate in a coating operation.

Rose, Jennifer, "Solder Joint Inspection Systems Aid Process Control Efforts," Connection Technology (February 1989), pp. 25-27.

Sophisticated computerized technologies for analyzing the quality of the solder joint is critical in the process control of soldering in electronics manufacturing. A vision system may be inadequate since many joints are hidden from view. Several non-destructive inspection systems are either under development or currently available. The most viable technologies for obtaining the image (data) involved either infrared detection, a combination of laser/infrared, ultrasonics, or x-rays.

Schreiber, Rita R., "Sensors," Robotics Today (May 1983), pp. 16-17.

Describes Ford Motor Company's plans to use the cyto-computer vision system from Synthetic Vision Systems, Inc. to verify precision circuitry. The model 815 passive infrared sensing module is described as the first practical system designed to precisely detect an object by sensing the thermal contrast between the moving object and its background.



- Seitzer, T., "Industrial Vision tackles Web Inspection," Advanced Imaging (February 1993) pp. 32-34.  
Overview of web inspection markets opening up recently to machine vision. Discusses applications from steel to newsprint, continuous pavement surfaces to food harvesting. Discusses technologies which make inspection possible, some infrared.
- Setzer, J.B., M. Thangavelu, "Infrared Sensor for Automated Inspection of Hot Metal Surface," SPIE Thermosense XII (April 1990) pp. 200-206.  
Authors describe how a linear infrared sensor could be used for automated inspection of hot metal sheets. The sensor locates voids, inclusions, and surface defects characterized by a variation from background radiant flux. The sensor can be coupled with a commercially available processing system, developed for visible wavelength line scan cameras, to automatically track, classify, and report product flaws in real time.
- Shelley, S., "Real-Time Emissions Monitors Now Detect Smaller Quantities of More Compounds at Breakneck Speed," Chemical Engineering (November 1991) pp. 30-39.  
Discusses the growing area of continuous emissions monitoring, which would use an "open path" or "fenceline" monitoring systems based on infrared optics. The system would pick up emissions in plants such as pul-and-paper mills, petroleum refineries and waste incinerators, and monitor the level of government regulated gases entering the air.
- Smith, C., "Noncontact High-Temp Measurement," Photonics Spectra (July 1992) pp. 22-24.  
Special filtering at narrow spectral ranges makes it possible to measure high surface temperatures through glass ports, flames, and products of combustion using non-contact IR thermometers. This article outlines well the areas of application more likely to favor point infrared radiometers rather than linear or scanning systems.
- Stern, H., "Machine Vision Turns From Autos to Electronics: Standards Hold the Key to Success," Photonics Spectra (December 1991) pp. 101-104.  
Machine vision, its hope in automobile production diminished, has found relief in electronics inspection. The author discusses what is available, what needs to be done to integrate an inspection system into existing processes, and the mechanics of conducting automatic inspections.
- Stinson, S.C., "Advances Made in APplying IR Sensors to Process Control," Chemical and Engineering News (January 9, 1989) pp. 30-31.  
Discusses two developments in infrared spectroscopy which have deepened interest in applying IR sensors to chemical and plant and oil refinery process control. One monitors multicomponent gas flows. The other determines gasoline octane numbers from IR spectra.
- Stout, A., "IR Aids Development of High-Power Chips," Photonics Spectra (November 1992) pp. 24-26.  
Infrared technology is being used to test cooling integrated circuit boards for high-power computer chips that are still on the drawing board. Since a deviation of 5 degrees on any component can affect operating speed, performance, and overall integrity, infrared detectors can profile chips and confirm that temperatures remain within those ranges.
- Teich, Andrew C., "Predictive Maintenance with Thermography in Paper Mills," PaperAge (Forthcoming, 1992), 5 pgs.  
A very good introductory, plain speaking article which describes how thermography is rapidly emerging as one of the most valuable resources available for predictive plant maintenance, detecting hidden problems in factories and allowing for corrective action before costly system failures occur. Applications in present use include surveying roofs for leaks, and checking rotating mechanical equipment such as electric motors,

bearings, and conveyors for signs of heat. Electrical distribution and motor control centers can be monitored for loose connections and phase imbalances. Circuit overload conditions can be detected long before burn marks for discoloration occur on the wire insulation. Other applications include refractory lining breakdown analysis, roof moisture detection, building envelope studies, steam trap conditions, heat exchanger evaluations and even the location of spontaneous combustion of stored paper products in ware houses and paper making supplies in outside yards.

Tervo, M., Kiukaaniemi, E., and T. Kauppinen, "Applications of Aerial Thermography in Peat Production in Finland," SPIE Thermosense XV Conference (April 1993), Paper 1933-14.

"Thermography Monitors Weld Quality," Quality (January 1992) pp. 37.

Discusses new servo-style automated system to perform resistance welding and percussive arc welding.

Tournerie, B., Reungoat, B. and J. Frene, "Temperature Measurements by Infrared Thermography in the Interface of a Radial Face Seal," Journal of Tribology, Transactions of the ASME (July 3 1991), pp. 571-76.

Mechanical seal functioning can be greatly affected by thermal effects and particularly by the coupling of seal face geometry and heat dissipation in the interface. It is necessary to develop new investigation means in order to study accurately such very delicate phenomena. This paper deals with the feasibility of temperature measurements by means of infrared thermography technique. The capabilities of the infrared camera which has been used are examined.

Travis, M., "Color Vision Helps Manufacturing and Quality of Food Products," Photonics Spectra (September 1992) pp. 139-143.

Although IR is not discussed, author outlines all areas of food inspection, from picking to automated inspection, which could use machine vision. Describes systems design, system integration, and other parameters in putting together an automated vision system which works for food inspection.

Valenti, M., "Infrared Sensors: Hands-Off Temperature Measurement," Mechanical Engineering (October 1991) pp. 40-45.

Survey article which discusses how noncontact heat-measurement instruments, known as radiation thermometers, have evolved into compact sophisticated devices that accurately measure temperature in a wide variety of industrial applications, from steel and glass production to the manufacture of semiconductor chips.

Vanzetti, Riccardo, "Combining Soldering with Inspection," IEEE Control Systems Magazine (v.5, 1988), pp. 29-32.

A procedure is described in which an infrared detector is used to control the quality of solder joints being formed on printed circuit boards and a laser is used to inspect the quality of each joint at the same time. This approach eliminates after-the-fact inspection while making available real-time data for process control of the soldering operation. Although the joints are formed one at a time, with somewhat longer manufacturing time as compared to alternative processes, the extra time is partly compensated for by elimination of a separate inspection. Moreover, when joints of different sizes occur on the same circuit board, each one receives a tailored amount of reflow energy, thus avoiding underheating or overheating, which can occur when the entire board is soldered at once.

Vanzetti, Riccardo, Intelligent Laser Does Soldering, Inspection and Process Control (SME, 1988), 20 pgs.

A method is described in which an infrared detector controls quality of solder joints being formed by laser beam heating on printed circuit boards while, at the same time, automatically inspecting the quality of just

made joint. It eliminates the after-the-fact inspection process while simultaneously making available real time data for process control of the soldering operation. A similar method for inspecting solder joints on previously built PCBS is addressed.

Vanzetti, Riccardo and Dr. Alan C. Traub, Laser Soldering and Inspection for SMD's and FPT (SME, 1989), 11 pgs.

A means of manufacturing solder joints by laser-beam reflow in combination with infrared thermal sensing controls the heating process for each joint. The method tailors the heating dosage to the heating requirements for each joint, thus accommodating variations in thermal mass or in the amount of heat sinking by adjoining parts. In this method, the surface temperature of each solder mass is brought quickly to its melting temperature, the laser power is then reduced and controlled, via feedback, in order to give the rest of the solder mass time to reflow. The thermal signature of each reflowed target, as seen by the infrared detector, indicates whether the joint is normal or whether it may have been defective due to poor preparation beforehand.

Wallin, B., "Real-Time Temperature Measurement on PCBs, Hybrids, and Microchips," SPIE Thermosense XIII Conference (April 1991) pp. 180-187.

Author at AGEMA Infrared explains how their systems offer the potential to perform thermographic inspections for this application.

Warren, C., "Infrared Thermometers: Out of the Lab and into the Factory," Machine Design (November 22, 1990) pp. 85-88.

Discusses the variety of industrial jobs in which infrared thermometers (both simple and linear) are used. Describes their advantages over contact thermometers, and basic principles behind their functioning and integration into industrial processes.

Willis, H.A., "Review of Industrial and Process Applications of Infrared Spectroscopy," (SPIE paper 1320-01) 1990. Work mainly relates to applications under research in the United Kingdom.

Welty, G., "When Bearings Fail...," Railway Age (December 1991) pp. 40-58.

When journal roller bearings in railway cars fail, the \$200 components could cause millions of dollars of damage. The need for improved, early-warning, hot-bearing detectors is clear. Acoustic detectors are one approach, IR detectors are another.

Wilson, J.S., "Thermal Analysis of the Bottle Forming Process," SPIE Thermosense XIII Conference (April 1991) pp. 219-229.

Explains efforts at Coors to integrate IR scanners to monitor bottle production in the Vertiflow cooling system, to increase yield. Thermal imaging is used to analyze the cooling effect due to different variable changes. The goal is to achieve uniformity in the iron temperature and glass flow which improves the quality of the bottle and also allows for a reduction in the total amount of glass required for each bottle.

Wright, J., "Infrared Measures Solder," Quality (June 1990) pp. 52-53.

Describes how simple IR thermometers can be used potentially to meet Nave Weapons specification WS-6536E (June 10, 1985) that requires all soldering irons used on products manufactured under a Naval Air contract be checked weekly to ensure that tip temperatures meet specification requirements.

#### (viii) Applications of IR Sensitive Materials in Remote Sensing

"Airborne IR Sensors Search Out Waste Sites," Photonics Spectra (July 1991), pp. 39-42.

Discusses how an IRFPA based sensor is being used to scan the formerly East German countryside for forgotten toxic-waste sights. As toxic waste decomposes, it releases heat, which is shown by the sensors flown by a plane at 1000 meters altitude. A large problem was distinguishing between background noise and genuinely hotter areas. Another problem was that weather conditions, the terrain of the survey area and discovering what's naturally hot can complicate, and in some cases, increase the costs of a survey. The licensing company is booked with customers.

Allen, A.R., S.A. Semanovich, "Thermal Analysis of Masonry Block Buildings During Construction," SPIE Thermosense XIII Conference (April 1991) pp. 99-103.

Asker, J., "Commercial Remote Sensing Faces Challenges on Three Fronts," Aviation Week & Space Technology (July 13, 1992) pp. 53-59.

Facing the possibility of new competitors later in the decade, the two leaders in the world satellite remote sensing market, Eosat and Spot, are planning for new technologies, grappling with US legislative uncertainty, and simultaneously nurturing established market relations while seeking new customers. IR technology is not addressed directly. Instead, the focus is on the future of the commercial satellite market.

Asker, J., "Remote Sensing Sales Grow with Expanded Data Needs," Aviation Week & Space Technology (July 13, 1992) pp. 46-51.

A survey of the most significant developments in space and information technology, along with the market trends, which will shape the space remote sensing business in the coming decade. This is a good article on the large potential for commercial satellites, and describes how new technologies will increase the versatility of the satellites, and create demand.

Carts, Y., "Automated Spectroscopy System Measures Smog," Laser Focus World (June 1993) pp. 23-24.

Spectrometers have been developed at the Lund Institute of Technology (Sweden) to measure a variety of atmospheric pollutants, including ozone, ammonia, nitrogen, and sulfur oxides, and aromatic hydrocarbons.

Colantano, A., "Metal Cladding Envelope Problems, Retrofit Solutions, and Quality Control Investigations," SPIE 14 pp. 64-73.

Explains the use of IR thermography to find air leakage in complex, retrofitted, rebuilt etc. buildings.

Everitt, J.H., "Introduction to Videography: Historical Overview, Relation to Remote Sensing, Advantages, Disadvantages," First Workshop on Videography (19-20 May 1988) 4 pgs.

The researcher, at the US Department of Agriculture, offers an introduction to videography technology, focusing exclusively on it as a research tool.

"Fighting Forest Fires With Remote Sensing," Photonics Spectra (August 1991), p. 66.

A joint venture of scientists at Terra-Mar Resource Information Services and NASA's Ames Research Center plans to develop in three years a commercially viable real-time remote sensing system for monitoring such disasters as fires, oil spills, and floods. If the system works, it should take less than 30 minutes to provide fire fighters with images showing a fire's intensity and location. Current systems, relying on film, can take 6 to 12 hours.

Fouche, P.S., "Assessment of Crop Stress Conditions by Using Low Altitude Aerial Color Infrared Photography and Computer Processing," Proceedings of the 13th Biennial Workshop on Color Aerial Photography and Videography in the Plant Sciences (6-9 May 1992) pp. 19-23.

Infrared imagery was found useful in the detection of stress condition in various crops caused by moisture

deficiency, nutrient deficiency, and plant diseases.

Gordon, D.K., P.W. Mueller, M. Heric, "An Analysis of TIMS Imagery for the Identification of Manmade Objects," Photogrammetric Engineering & Remote Sensing (December 1991) pp. 1599-1604.

Concluded that a multispectral thermal infrared capability may have considerable value in reconnaissance sensor packages such as Aided Target Recognition because objects such as metal- and stone-covered roofs were easily detected using the airborne Thermal Infrared Multispectral Scanner (TIMS).

Green, R., "Remote Sensing Soars to New Heights," Photonics Spectra (August 1991) p.81.

Leading the way to remote sensing with greater spatial, spectral and radiometric sensitivity is the Airborne Visible/ Infrared Imaging Spectrometer by the Jet Propulsion Laboratory. Using silicon and Indium antimonide line-array detectors, the instrument is bringing new capabilities to scientists studying ecology, geology, oceanography, inland water supply, snow hydrology and the atmosphere.

Hock, J.C., "Monitoring Environmental Resources Through NOAA's Polar Orbiting Satellites," Thermology (1: 1986) pp. 154-160.

Good overview of the environmental monitoring missions served by infrared detectors. The MWIR and LWIR channels are mostly used for cloud and surface temperature determination, and rainfall estimates.

Jiang, H., Y. Qian and K.T. Rhee, "High-Speed Dual-Spectra Infrared Imaging," Optical Engineering (June 1993) pp. 1281-1289.

A new method of achieving controlled high-speed infrared imaging is presented, which has made it possible to overcome some of the limitations in current imaging technology, particularly in disposal of high-rate data flow synchronized with the event or object being detected. This technique is employed to simultaneously capture two geometrically identical images in respective spectral bands for quantitative spectrometric data reduction.

Jones, T., "Lack of Photos Hurt Yellowstone Fight," Los Angeles Times (October 21, 1988) pp. 116.

The battles against a Yellowstone national park blaze was hampered by lack of infrared aerial photos, which were slow in being supplied due to communication problems.

Kaasinen, H.I., "Infrared Thermography for Assessing the Quality of Waterproofing of Bridges Under Construction," SPIE Thermosense XV Conference (April 1993) Paper 1933-07.

This application appears to be very similar to roof moisture surveys, only more sophisticated and demanding of the detectors.

Kaplan, H., "Using Laser Backscatter to Find Gas Leaks," Photonics Spectra (June 1991) pp. 98-100.

Researchers at the Livermore National Laboratory developed a gas-leak detection system based on "laser backscatter/absorption gas imaging (BAGI)" for the Naval Sea Systems Command which has commercial application. It can detect gas leaks which cost companies money, and, if the gases are toxic, could detect the release of hazardous gases before anyone is harmed. The technology is being marketed by Laser Imaging Systems of Punta Gorda, FL. The system uses a LWIR system. Article explores various applications for the BAGI system.

Kaupinnen, R., et. al., "Renovation Concepts for Private Houses: The Use of Thermography as A Supporting Method," SPIE pp.54-63.

Explains various ways Finland's Department of Energy is using, and has proposed the use of, infrared imagers in weatherproofing, and checking the air-tightness of homes.

- Keutler, D.J., "Insights into Interpretability Differences Between Color Infrared Photography and Color Infrared Video Data," Proceedings of the Thirteenth Biennial Workshop on Color Aerial Photography and Videography in the Plant Sciences (6-9 May 1992) pp. 110-117.  
Typical of the many articles on detection of plant stress using near infrared video or photography. Has good review of uses and history of color infrared photography and videography.
- Knechans, A., and J. Ledford, "Impact of Aerial Infrared Roof Moisture Scans on the U.S. Army's Roofer Program," SPIE Thermosense XV Conference (April 1993) Paper 1933-10.
- Koskelainen, L., "Predictive Maintenance of District Heating Networks by Infrared Measurement," SPI14 pp.89-96.  
Although there were several articles over the years on this subject, the application seemed to only interest the scandinavian countries, so the application was left out of our final report.
- Larceau, A.G., "Flight Performance of an Airborne Minefield Detection and Reconnaissance System," Photogrammetric Engineering & Remote Sensing (February 1991) pp. 173-178.  
Reports on how the Airborne Minefield Detection and Reconnaissance System, developed by the US Army, could succeed in detecting mines using IR technology. The system uses a passive IR linescan sensor in the LWIR. The paper reports on the performance of the system.
- Lightfoot, D., and V. Lightfoot, "Revealing the Ancient World Through High Technology," Technology Review (May/June 1989) pp. 54-61.  
Discusses how color infrared photography and videography offer a new frontier for archeologists studying and searching for ancient cultures. Features such as dwellings, agricultural fields, and footpaths have been located easily using IR imagery. Airplane archeology using IR imagery should continue, the authors predict, to be invaluable to archeologists.
- Linkous, A., B. McKnight, "Using Thermography to Detect and Measure Wall Thinning," SPIE Thermosense XV (April 1993) Paper 1933-04).  
A new buildings & structures application.
- Lyberg, M.D. and S. Ljungberg, "Thermography and Complementary Methods; A Tool for Cost-Effective Measures in Retrofitting Buildings," SPIE Thermosense XIII Conference (April 1991) pp. 104-116.
- Marsh, S.E., J.L. Walsh, C.T. Lee, L.A. Graham., "Multitemporal Analysis of Hazardous Waste Sites Through the Use of a New Bi-Spectral Video Remote Sensing System and Standard Color-IR Photography," Photogrammetric Engineering & Remote Sensing (September 1991) pp. 1221-1226.  
Reports on a study which combined standard aerial color infrared photography, a new bi-spectral video acquisition systems, and GIS software to evaluate conditions at a waste site near Phoenix, Arizona. Found that a video system offers several potential advantages over conventional photography for an operational monitoring program, including the immediate availability of multispectral data.
- Mausel, P.W., "Airborne Videography: Current Status and Future Perspectives," Photogrammetric Engineering & Remote Sensing (August 1992) pp. 1189-1195.  
Video imagery has only been used in remote sensing for about ten years, but new technologies, such as CCDs, offer higher resolution than had been previously available. The low resolution of videographic equipment had limited the technology's potential. Although all varieties of wavelengths are discussed, a video system used in the mid-wave IR could distinguish among plant species, determine succulent and non-succulent plant species, identify crop irrigation management potential, differentiate between variable soil surface conditions, and detect wild fires. Best survey article on the direction of photogrammetry.

McMullan, P.C., "Masonry Building Envelope Analysis," SPIE Thermosense XV Conference (April 1993) Paper 1933-06.

McMullan, P.C., "Field Documentation and Client Presentation of Infrared Inspections on New Masonry Structures," SPIE Thermosense XIII Conference (April 1991) pp. 66-74.

McMullan, P.C., "Case Study of Commercial Building Envelope Air Leakage Detection Using Infrared Imaging," SPI14 pp. 74-83.

Mecham, M., "Europeans Prepare to Build on Early ERS Satellite Success," Aviation Week & Space Technology (July 13, 1989) pp. 68-69.

The European Space Agency plans to build a second European Remote Sensing Satellite. The technology to be used (including IR) are explained, and the political and funding scenario for such a satellite are discussed.

Morgan, W.T., "Thermographic Inspections of Air Distribution Systems," SPI14 pp. 85-8.

Narayanan, R.M., S.E. Green, D.R. Alexander, "Soil Classifications Using Mid-Infrared Off-Normal Active Differential Reflectance Characteristics," Photogrammetric Engineering & Remote Sensing (February 1992) pp. 193-199.

Using laser fluorescence, found that different soil samples have unique reflectance signatures in the 9-11 micron region. Recommends that wavelength's use for understanding soil composition.

Nordstrom, R.J., "The CO2 Laser In Remote Sensing," Photonics Spectra (February 1992) pp.89-94

Discusses the range of uses for the CO2 laser, which is the illuminator of choice for infrared applications because it operates optimally within the 8-12 micron range. The 8-12 micron range is called the "fingerprint region" of the spectrum because so many molecules have distinct vibration bands there. This single distinction is enough to make the CO2 an instrument of choice despite its relatively poor atmospheric transmittance.

Nordwall, B.D., "Airborne Surveillance Will Give Forest Service Real-Time Fire Maps," Aviation Week & Space Technology (May 29, 1989) pp. 105-107.

Reports that the US Forest Service plans to use two aircraft equipped with dual-band IR sensors and a Navstar Global Positions System to locate fires and immediately send information to firefighters on the ground. Explains the equipment installed in two aircraft, and the techniques which have been designed for collecting and quickly relaying information to the ground.

Olsen, J.D., "Airborne Multispectral Imaging Monitor Environment," Photonics Spectra (August 1992) p.71

The information in the imagery significantly affected site investigations by identifying representative locations for observation and testing, detecting anomalous conditions for special investigation and refocusing investigations to an area that was initially considered off-site. The use of remote sensing as an analytical tool resulted in reduced site-investigation time and costs, improved company and regulatory communication, and reduced time for site closure. The source of the chemical contamination at a pesticide plant was revealed on images in the near-infrared and thermal-infrared bands by vegetation stress.

"Panel Picks Priorities for Astronomy Research," Chemical and Engineering News (March 25, 1991), pp. 6.

A report coming from the National Research Council, entitled "The Decade of Discovery in Astronomy and Astrophysics," stresses that two technologies are liable to have the greatest impact: infrared technology and adaptive optics (that is, "giving Earth-based telescopes optics that respond quickly to eliminate atmospheric

distorting effects.

Parsons, M.L., et. al., "Fire Detection Systems for Aircraft Cargo Bays," (SPIE Paper 1308-29) 1990, 13pgs.  
Discussion of an application using linear IRFPAs designed at Pacific Scientific Co.

Pierce, L.L., S.W. Running, G. Riggs, "Remote Detection of Canopy Water Stress in Coniferous Forests Using the NS001 Thematic Mapper Simulator and the Thermal Infrared Multispectral Scanner," Photogrammetric Engineering and Remote Sensing (May 1990) pp.579-586.  
Concluded that neither system could effectively detect moderate levels of canopy water stress, although extreme stress was easily detected.

Proctor, P., "Japan Plans New Generation of Remote Sensing Satellites," Aviation Week & Space Technology (July 13, 1992) pp. 66-67.

Schott, L.R., "Image Processing of Thermal Infrared Images," Photogrammetry Engineering and Remote Sensing (September 1989) pp. 1311-1321.  
Technical piece which discusses how to implement absolute temperature calibration algorithms, methods for registering and combining multiple thermal infrared images, and methods for combining thermal infrared reflected visible and near-infrared data.

Shropshire, G., and J. DeShazer, "Optical Sensors Aid Agriculture," Laser Focus World (May 1993) pp. 79-84.  
Discusses development of sensors to reduce the use of chemicals and conserve natural resources in agriculture. Optical-based sensors used in agriculture represent one area in which strides are being made to analyze and improve our environment, in soil analysis, ammonia sensing, detecting plant stress and finding weeds.

Sopko, V., "Discussion of the Standard Practice for the Location of Wet Insulation in Roofing Systems Using Infrared Imaging (ASTM C1153-90)," SPIE Thermosense XIII Conference (April 1991) pp. 83-89.

Sundberg, J., "Use of Thermography to Register Air Temperature in Cross Sections of Rooms and to Visualize the Air Flow From Air Supply Diffusers," SPIE Thermosense XV Conference (April 1993) Paper 1933-08.

Stout, A., "IR Images and Environmental Sleuths," Photonics Spectra (December 1991), p.117-120  
Discusses Nancy Del Grande, at the Lawrence Livermore Laboratory, who is putting an AGEMA infrared systems Thermovision 880 infrared burst scanner to work to search for buried and covered, as well as exposed, objects that heat and cool at rates different from those of the surrounding soil. Uses include: mine detection, aquifers, nuclear testing size verification, building structures, buried archeological sites excavation.

Tobiasson, W., and A. Grotorex, "Use of an Infrared Scanner and a Nuclear Meter to Find Wet Insulation in a Ballasted Roof," SPIE Thermosense XV Conference (April 1993) Paper 1933-09.

Tomlinson, P.D., "Predictive Maintenance : Key to an Effective, Cost-Saving Maintenance Program," Complete Building Equipment Maintenance Desk Book, S.J. Fuchs (ed.) (Prentice Hall: Englewood, NJ.) 1982 pp. 39-65.

Tulloch, M., "IR IMaging Studies Solar Atmosphere," Photonics Spectra (September 1991) pp. 18.  
A researcher at the Smithsonian Astrophysics Observatory recorded a solar eclipse in near-IR wavelengths to determine if the sun is encircled by rings of interplanetary dust or rocks, which would be left from the early stage of development of the solar system. The camera used was based on a 128x128 InSb focal plane array.



- Tulloch, M., "Auroral Imaging to Aid Ionosphere Monitoring," Photonics Spectra (March 1992) p.18.  
An integrated system of sensors- IR, UV, and visible, has been proposed for global space weather systems to detect occurrences in the ionosphere and forecasts its fluctuations. This would help the operation of communications, navigation, and radar systems that depend on conditions in the Earth's upper atmosphere.
- Tulloch, M., "Photonic Technology Assists Oakland Firestorm Efforts," Photonics Spectra (December 1991) pp. 18-20.  
During an Oakland fire on October 20, research aircraft from NASA Ames Research Center tracked the firestorm with infrared scanners and cameras to provide maps of the fire region. These aerial images gave fire fighters the first high-resolution overview of the firelines, hot spots and smoldering areas about to reignite.
- Vlcek, J., "Nature of Video Images," First Workshops on Videography (19-20 May 1988) 5 pgs.  
Focuses primarily on remote sensing aerial video, including IR, for forestry and land use applications.
- Waggoner, J., "Optical Filters a Critical Part of Environmental Monitors," Photonics Spectra (July 1991) p. 18.  
When an oil monitor is designed using an IR source, a 3.4 micron band pass filter and a detector, it is possible to easily measure concentrations as low as 1 ppm for oil. For a given absorbance signal, this simple device is three times more sensitive than the FTIR spectrometer and ten times more sensitive than grating IR spectrometers.
- Weil, G.J., "Detecting the Defects," Civil Engineering (September 1989) pp. 74-77.  
Infrared thermography exposes minor structural problems before they become major catastrophes in areas such as highway pavement, sewers, bridges, water lines. The result: lower repair costs.
- Weil, G.J., "Nondestructive Remote Sensing of Buried Tanks," Unpublished  
Details how infrared thermography was used during an environmental assessment of a 50 acre industrial plant site to locate buried industrial waste materials, such as underground storage tanks, and miscellaneous waste items as small as a 55 gallon drum.
- Weil, G.J., "Nondestructive Remote Sensing of Hazardous Waste Sites," SPIE Thermosense XV Conference (April 1993) Paper 1933-31.  
Describes EnTech Inc.'s combination Ground Penetrating Radar- IR Thermography technology, in use for detection of hazardous waste leaks & buried drums. Discusses the growing demand for such land surveys, and offers three case studies: a West Coast Air Force Base, a US Government testing laboratory, and a rehabilitated gasoline station.
- Weil, G.J. and R.J. Graf, "Infrared Thermography-Based Pipeline Leak Detection Systems," SPIE Thermosense XIII Conference (April 1991) pp. 18-33.  
Describe EnTech's technique, using GPR and IR. The technique has been used to test pipelines in chemical plants, water supply systems, steam lines, natural gas pipelines, and sewer systems. The paper details the development of a computerized system using GPR and IR, with several case studies.
- Weil, G.J., "Non-Destructive Testing of Bridge, Highway, and Airport Pavements," Unpublished, 13 pgs.  
Describes how GPR and IR techniques can, in conjunction, be used to inspect concrete structures rapidly and economically. Discusses in detail the requirements for an automated inspection systems, and explains with several case studies how the joint IR/GPR technique can fulfill the inspection needs.
- Wiegand, C.L., D.E. Escobar, J.H. Everitt, "Comparison of Vegetation Indices from Aerial Video and Held-held

Radiometer Observations for Wheat and Corn," Proceedings of the Thirteenth Biennial Workshop on Color Aerial Photography and Videography in the Plant Sciences (6-9 May 1992) pp. 99-105.

Finds that the automatic gain control in video cameras can complicate multitemporal analyses of crop health, since the overflight video imagery was much more variable day-to-day than on-ground radiometric readings. Study recommends some ways it has or recommends dealing with this auto gain control variation.

Wilson, B.A. (ed), "Sensor Systems for Space Astrophysics in the 21st Century," Workshop Proceedings from NASA conference NASA-CR-189449 (August 1, 1991) 80pgs.

This report was prepared by one of the three Integrated Technology Planning workshops initiated in 1989 by the Astrophysics Division of the Office of Space Science and Application within NASA. Its objectives were to develop an understanding of future missions requirements for electromagnetic radiation sensor systems, and to recommend a comprehensive development program to achieve the required capabilities. There is discussion of the passive IR sensors required for space in the years ahead.

**(ix) Applications of IR Sensitive Materials in Surveillance**

Aikens, D.M., "Airborne Infrared and Visible Sensors Used for Law Enforcement and Drug Interdiction," SPIE Conference on Surveillance Technologies (April 1991) pp. 435-44.

Discusses some of the applications of visible and IR sensors in law enforcement and the issues peculiar to their use in that community. Sensor technology which are both currently available and forthcoming are described.

Berardomos, L.A., "No Place to Hide: The Ability to Fight at Night May have Been the Deciding Factor in the Gulf War and in Panama, but the Equipment That Makes it Possible is Still Getting Better," Machine Design (October 24, 1991) pp. 57-61.

Blackwell, J.D., "High Performance InSb 256x256 Infrared Camera," SPIE Conference on Surveillance (April 1991) pp. 324-334.

More a discussion of the camera's potential than a direct relation to the needs of surveillance applications.

Bruder, J.A., et. al., "Detection of Contraband Brought into the United States by Aircraft and other Transportation Methods: A Changing Problem," SPIE Conference on Surveillance (April 1991) pp. 316-323.

Executives at US Customs Service discuss the latest in counter-detection methods used by smugglers, and other innovative ways to avoid detection of their contraband. Intended to facilitate thinking on technologies to counter such attempts at avoidance.

Byrd, V., "Helping Police See in the Dark," New York Times (September 27, 1992) pp. K9.

Discusses NYC police use of night vision goggles to approach locales where they don't want to use a flashlight.

Cantell, M.J., "Infrared CCD Sensor for Surveillance," SPIE Conference on Surveillance Technologies and Imaging Components (April 1993) 12 pgs.

"Coast Guard Uses Hu-25 FLIR, Radar to Detect Smugglers," Aviation Week & Space Technology (January 30, 1989) pp. 42-43.

Westinghouse F-16 radar and FLIR systems have provided Coast Guard Hy-25 Falcons with the day-night capability they need to be a more effective combat air patrol for aerial drug interdiction. Whereas radar picks up the faraway signals of suspicious planes, infrared detectors allow pursuers to sneak up without giving away their location.

Creel, R., "Airborne Law Enforcement Association: 1992 National Database Summary," Airborne Law Enforcement Association (August 1, 1992) 6 pgs.

Survey of which photonic equipment was used by the ALEA's airborne members, which were most helpful, how much money in contraband was confiscated using that equipment, how many criminals arrested with the help of that equipment, etc.

Cullen, R.M., "Low-Cost Space Platforms for Detection and Tracking Technologies," SPIE Conference on Surveillance Technologies (April 1991) pp. 295-305.

Outlines possibilities of satellites, currently and soon to be deployed, in surveillance.

Del Grande, N.K., et. al., "Buried Object Remote Detection For Law Enforcement," SPIE Conference on Surveillance Technologies (April 1991) pp. 335-51.

Another application for the dual-use infrared detector designed by researchers at the Lawrence Livermore National Labs. Their technology could be easily modified for drug interdiction and pollution control, for finding jungle canopies and covered containers used for contraband, and to depict buried waste containers, sludge migration pathways from faulty containers, and the juxtaposition of groundwater channels, if present, nearby. The dual bandIR technology could detect underground epicenters of smuggling and pollution.

Dial, O.E., "CCD Performance Model," SPIE Conference on Surveillance Technologies (April 1991) pp. 2-11.

Relates CCD technology to applications in surveillance.

Elerding, G.T., J.G. Thurnen, L.M. Woody, "Wedge Imaging Spectrometer: Application to Drug and Pollution Law Enforcement," SPIE Conference on Surveillance Technologies (April 1991) pp. 13 pgs.

Designers at Hughes Aircraft have invented the wedge imaging spectrometer which is compact and rugged, and suitable for use in drug interdiction and pollution monitoring activities by detecting small quantities of gases remotely. Uses a focal plane array.

"EMS Pilots Disagree on Value of Night-Vision Goggles," Helicopter News (October 30, 1992) pp. 1,4.

Reports on the reactions of aeromedical pilots meeting at annual Air Medical Transport Conference in Salt Lake City, Utah, to night vision goggles. Older pilots who used earlier NVGs disliked the technology, and constituted the majority of attendees.

Frank, J., "Out of the Darkness," Security Management (August 1991) pp. 45-47.

Discusses how focal plane array-based surveillance cameras could revolutionize nighttime security.

"Gotcha, for Now," The Economist (March 11, 1989) pp. 32.

Since police can no longer count on radar to detect speeders, since almost 15 percent of drivers use radar detectors, their newest weapon is a speed detector that uses infrared lasers, which of course, cannot be sensed by radar detectors. The system, however, does not use focal plane arrays. The article is included because several people had suspected that IR could be used to detect speeding vehicles.

Henderson, B.W., "Radar/Digital Adapting P-3 AEW Radar for Small Drug Interdiction Aircraft," Aviation Week & Space Technology (February 24, 1992) pp. 128-29.

Radar/Digital Systems is developing a system that will allow drug enforcement officials on small aircraft to combine radar and FLIRS on a single display. The system would make it easier for drug agents to track smugglers and force them to land.

Holton, W.C., "Tales From the Dark Side: Shedding New Light on Crime: Photonics Join the Law Enforcement Arsenal," Photonics Spectra (December 1992) pp. 52-61.

Extensive coverage of photonics technologies applied to law enforcement and surveillance, especially focal plane array based cameras for drug interdiction and police use.

"IR, Optical Sensors Search Out Drug Labs" OE Reports (July 1992) 4.

This is an interview with Michael Calvert (a special agent with the California Department of Justice supervising a clandestine drug laboratory investigation team) and Nancy Del Grande (principal investigator for the FAA- sponsored Dual-Band IR Imaging for Aging Aircraft Inspection Project).

Johnson, C., "Police Tools of the 90's Are Highly Advanced, but Privacy Laws Lag," Wall Street Journal (November 12, 1990) pp. A1, 10.

Discusses upcoming police use of Unmanned Aerial Vehicles for surveillance, which have on-board high resolution cameras, infrared detectors, and chemical sensors.

Kulp, T.J., et. al., "Application of Backscatter Absorption Gas Imaging to the Detection of Chemicals Related to Drug Production," SPIE Conference on Surveillance (April 1991) pp. 352-363.

A gas detection system originally designed by the Lawrence Livermore National Labs, and transferred to Laser Imaging Systems, could be used in the surveillance of suspected drug production sites.

Laband, S., "IR Imaging For Autonomous Pole-Mounted Surveillance," Photonics Spectra (January 1993) pp. 146.

Discusses Amber's new Radiance 1 surveillance camera which is lightweight, rugged, easy to install, etc., compared with older IR systems.

Lytle, David, "Night-Vision Devices Head for Civilian Market," Photonics Spectra (May 1991), pp. 68.

A brief article which explains that the Army's decision to declassify its uncooled thermal imaging sensor technology will encourage a slew of commercial spinoffs of its night vision: for police and fire department use, and for vision enhancers for nighttime drivers.

"Marines Respond to EMS Debate; Defend Night Vision Goggles," Helicopter News (March 19, 1993) pp. 8.

Two officers in the US Marine Helicopter Squadron One argue that the new night vision goggles can offer great potential in EMS missions. The FAA, however, remained steadfast in opposing NVGs, considering them unsafe for civilian operations.

Mataloni, R.J., "Application of Lighter-than-Air Platforms to Law Enforcement," SPIE Conference on Surveillance Technologies (April 1991) pp. 306-315.

Discusses possibilities for floating balloons and other platforms in aerial surveillance, including the use of IR detectors.

May, C., "New Devices May Stop More Bombs at the Gate," New York Times (December 25, 1988) pp. 11.

Pan Am World Airways flight that crashed in Scotland gave impetus to installation of new devices to stop bombs at airports, including TNA explosive detectors and infrared sensors.

McCauley, H., Auburn, J., "Image Enhancement of Infrared Uncooled Focal Plane Array Imagery," SPIE Conference on Surveillance Technologies (April 1991) pp. 416-422.

Proposes several low-cost algorithms to enhance uncooled FPA imagery.

Office of National Drug Control Policy, Counter-Drug Technology Assessment Center, Executive Office of the President, "Broad Agency Announcement BAA 92-15" 1992, 5 pgs.

Agency announcement for proposals from industry for technologies in four counter-drug areas: non-intrusive inspection, wide area surveillance, targeting of drug organizations, and demand reduction.

Robinson, C.A., "Arcane Science Sparkes in Drug Enforcement War: October Confab Showcases Array of Science to Stanch Contraband Flow," Signal (August 1992) pp. 21-27.

Preview of various innovative technologies to be shown in October 1992 international meeting on contraband and cargo inspection. No discussion of IR technologies; they would not be helpful in this area.

Williams, R.H., "The US Customs Service Spearheads the Drug War," Signal (December 1990) pp. 52-54.

Overview of technologies used by US Coast Guard for drug interdiction. Includes list of equipment used, such as infrared cameras.

Yanagimoto, S. and Seiji Yamamoto, "Thermal Imagers for Security Systems," Mitsubishi Electronic Advances (June 1991) p.2-4.

Security systems are becoming common in an ever widening variety of fields, the environments in which they are set are becoming more diverse, and these conditions are feeding a growing demand for video-surveillance systems that can exhibit more powerful monitoring functions under lightless conditions. This article describes the basic functions of the IR-5120C, and describes how it can be used in the security field.

#### (x) Applications of IR Sensitive Materials in Transportation

Appleby, R., et. al., "High Performance Passive Millimeter-Wave Imaging," Optical Engineering (June 1993) pp. 1370-1373.

Discusses the current status of passive MMW radiometry as a thermal imaging technique, which is a technology competing with IR cameras for airplane enhanced vision systems. The major problems are poor spatial resolution and slow response time. Techniques for overcoming these difficulties are identified, including the use of aperture synthesis, multichannel receivers, correlation, and inverse transform techniques. A comparison is made with infrared imaging.

"Army Promotes Defense Technologies for US Automakers," Aerospace Daily (March 9, 1993) pp. 382.

The Army showed off a number of defense technologies, including virtual prototyping, infrared focal plane arrays, and obstacle avoidance, that it believes could meet the needs of the domestic auto industry. They presented at the Automotive Technology Exposition at the University of Michigan, by the invitation of the sponsor, the US Council for Automotive Research.

Commander, U.S. Army CECOM, "Request for Procurement for Driver's Vision Enhancer (Solicitation Number DAAB0793RK007)," 2 March 1993.

Dornheim, M.A., "MMW Radar Shows Commercial Utility," Aviation Week & Space Technology (November 2, 1992) pp. 55-59.

The joint FAA/Defense Department/industry synthetic vision systems technology program for EVS is leaning towards radar rather than IR technology because it produces better images.

Figuroa, L., et. al., "Photonics Technology for Aerospace Applications," Photonics Spectra (July 1991) pp. 117-124.

Introduces several sophisticated control and communications systems for future aircraft and space systems. Includes fly-by-wire flight control systems, fiberoptic position sensor technology, multiplexing technology, and fiber optic data buses.

Holusha, J., "Infrared Rays May Improve Night Driving," New York Times (October 28, 1987) pp. D8.

General Motors Corp. and US automotive industry predict use of infrared lights to greatly improve night vision by year 1990!

Hughes, D., "Affordable Systems to Drive Civil, Military Electronics," Aviation Week & Space Technology (September 7, 1992) pp. 87-90.

Illustrates how formerly military-only firms are moving into the commercial sector with the enhanced vision system. Contrasts millimeter-wave technology with infrared; discusses firms in alliances to meet anticipated EVS demand.

Judycki, D., Euler, G., "The Intelligent Vehicle-Highway Systems Program in the United States," U.S. Department of Transportation, Federal Highway Administration (Unpublished) 15 pgs.

A complete overview of the IVHS program, discussing all programs, funding sources and scenarios, the role of private industry, and plans for the future.

Nordwall, B.D., "HUD With IR System Extends Pilot Vision," Aviation Week & Space Technology (February 22, 1993) pp. 62-63.

Reports on research at the Maryland Advanced Development Laboratory on enhanced vision systems combining heads-up displays with IR imagers.

Scott, William B., "Hughes Testing Radar, IR Sensors to Aid Reduced-Visibility Landings," Aviation Week & Space Technology (May 6, 1991), pp.49-50.

Hughes' new Commercial Division is seeking to further develop an IR sensor prototype which will permit commercial aircraft to land autonomously in adverse weather conditions, when pilot vision is limited. This reflects Hughes' desire to move towards a 60/40 mixture of military/commercial business by the mid-90s. The division is a bellweather for Hughes because the commercial avionics equipment is a departure from the usual military market.

Shoemaker, C., "DoD Unmanned Ground Vehicle Program," IVHS America Third Annual Meeting (April 14-17, 1993) 12 pgs.

Shulman, M., "AVCS From the Automobile Companies' Perspective," IVHS America Third Annual Meeting (April 14-17 1993) 15 pgs.

Overview of automobile companies' desires and technological challenges regarding the advanced vehicular collision avoidance system, which is part of the IVHS plan. Mentions briefly IR technologies for aided vision.

Tulloch, M., "Intelligent Vehicle Highway System," Photonics Spectra (February 1992) p.18

Discusses Siemen Automotive's new IVHS technology, which will integrate IRFPAs for various systems for guidance, lane reading, collision avoidance, etc.

"Using Cameras to See a Foggy Road," New York Times (August 8, 1990) D7.

Engineers at BMW are working on a system using video and infrared cameras to improve automobile drivers' perception of the road under conditions of poor visibility.

Welch, S.S., Sensors and Sensor Systems for Guidance and Navigation, (SPIE: WA) April 1992.

The recent growth of the number of applications for sensors in guidance and navigation has spawned a rapid development of technology. This proceedings presents the latest developments in sensor technology and applications. Papers discuss design, integration, characterization, materials, and sources for sensors operating in the IR, millimeter, radar and acoustic regimes. Several papers report innovative technology, emphasizing new materials and novel approaches to sensing, miniaturization, new sources, and signal processing.

Yazigi, M.P., "Promethean Plans for the Next Generation of Cars," New York Times (September 13, 1992) pp. E14.

A European project called Prometheus, which stands for Program for European Traffic of Highest Efficiency and Unprecedented Safety, is said to be perhaps the largest effort currently undertaken to equip automobiles with such devices as radar, lasers, and infrared cameras that are intended to enhance traffic safety. Some of the technology being put to use in the Prometheus project is discussed.

Appendix D  
Private Organizations Carrying out Research on Applications  
of Infrared Materials Database

**Organization:** Acme-Cleveland Corporation  
**Component:** Namco Controls Division  
**Address:** 7567 Tyler Blvd.  
Mentor, OH 44060  
**Contact:** Jon Slaybaugh  
**Position:** General Manager  
**Notes:** Product oriented R&D of electronic measurement and control devices including photoelectric sensors, laser guidance, identification and tracking devices.

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**Organization:** Adcole Corporation  
**Component:**  
**Address:** 669 forest St.  
Marlborough, MA 01752  
**Contact:** AD Cole  
**Position:** President  
**Notes:** Research on sun sensing systems, scientific instruments for rockets and satellites, linear and radial electro-optical measuring techniques, computer controlled cylindrical coordinate gauging equipment.

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**Organization:** Advanced Design Corporation  
**Component:**  
**Address:** 8560 Cinderbed Rd  
Newington, VA 22122  
**Contact:** Michael Coleman  
**Position:** Direng  
**Notes:** Product oriented electro-optics; night vision devices both image intensification and thermal imaging.

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**Organization:** Advanced Kinetics  
**Component:**  
**Address:** Unit 108, 18281 Gothard St.  
Huntington Beach, CA 92648  
**Contact:** Ronald Huynh  
**Position:** Pres  
**Notes:** Research in laser physics and applications, including IR sources (black bodies).



**Organization:** Advanced Technology Materials  
**Component:**  
**Address:** 520-B Danbury Road  
New Milford, CT 06776  
**Contact:** Glenn Tom  
**Position:** VPres Research  
**Notes:** Recently awarded an SDIO contract to develop a new electronic thin-film material to improve IR detector technology. The company will focus on using barium strontium titanate to develop new sensors capable of operating at room temperature.

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**Organization:** Advanced Technology Materials  
**Component:** Semiconductor Products Department  
**Address:** 7 Commerce Drive  
Danbury, CT 06810  
**Contact:** C.P. Beetz, Jr.  
**Position:** Mr.  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Buffer Layers for Deposition of Superconducting YBaCuO Thin Film on Polycrystalline Diamond"

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**Organization:** AEG  
**Component:**  
**Address:** D-7100 Heilbronn  
GERMANY  
**Contact:** H. Maier  
**Position:**  
**Notes:** Co-authored for 1991 MCT Workshop "Influence of Resonant Defect States on Subband Structures in HgCdTe"

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**Organization:** AEG  
**Component:**  
**Address:** D-7100 Heilbronn  
GERMANY  
**Contact:** H. Maier  
**Position:**  
**Notes:** Co-authored for 1991 MCT Workshop "Influence of Resonant Defect States on Subband Structures in HgCdTe"

**Organization:** Aerodyne Research, Inc.  
**Component:**  
**Address:** 45 Manning Rd.  
Billerica, MA 01821-3976  
**Contact:** Roger Putnam  
**Position:** Director of Marketing  
**Notes:** Basic and applied product-oriented research in electro-optical and photo-optical systems, combustions, atmospheric, and environmental science; molecular physics; laser development; spectroscopy; product surface chemistry; optical signal processing; optical computing.

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**Organization:** Aerojet Corp.  
**Component:** Electronic Systems Division  
**Address:** Azusa, CA  
**Contact:** H. Vydyanath  
**Position:** Mr.  
**Notes:** Co-authored for 1992 MCT Workshop "Photo-Induced Excess Low Frequency Noise in HgCdTe Photodiodes"

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**Organization:** Affiliated Manufacturers, Inc. (AMI)  
**Component:**  
**Address:** PO Box 5049  
North Branch, NJ 08876  
**Contact:** B Austin  
**Position:** CEO  
**Notes:** Process and manufacturing considerations of the microelectronics manufacturing industry; innovative manufacturing processes; thick film hybrid circuits.

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**Organization:** Agema Infrared Systems  
**Component:**  
**Address:** 550 County Avenue.  
Secaucus, N.J. 07094  
**Contact:** Philip Smith  
**Position:** President  
**Notes:** Manufactures infrared thermal imaging systems for condition monitoring, process monitoring and control, military/ defense research, surveillance and the nondestructive measurement and analysis of materials and components.

**Organization:** Agema IR Systems  
**Component:**  
**Address:** 550 County Avenue  
Secaucus, NJ 07094  
**Contact:** Jay Levy  
**Position:** Communications Director  
**Notes:**

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**Organization:** AGR International, Inc.  
**Component:**  
**Address:** PO Box 149  
Butler, PA 16003-0149  
**Contact:** John Wasylyk  
**Position:** Director of Research  
**Notes:** Development of optical inspection techniques for process control in glass container manufacturing.

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**Organization:** AIL Systems, Inc.  
**Component:**  
**Address:** Commack Road  
Deer Park, NY 11729  
**Contact:** Harvey N. Kreisberg  
**Position:** Director Corporate Development  
**Notes:** Manufactures Infrared systems & equipment, alongside RF & Microwave and other passive and active systems

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**Organization:** Air Products and Chemicals, Inc.  
**Component:** Gas Group  
**Address:** 7201 Hamilton Blvd  
Allentown, PA 18195-1501  
**Contact:** Brian Rushton  
**Position:** VP R&D  
**Notes:** Applications R&D for infrared spectroscopy.

**Organization:** Alabama University in Huntsville  
**Component:**  
**Address:** Huntsville, AL  
**Contact:**  
**Position:**  
**Notes:** Authored "Focal Plane Array Testing Support" in January 1992, 55 pages. No author given.  
Founded in 1985, the center has programs in nonlinear optics, crystal growth, high Tc superconducting infrared detectors, and optical design. Adjacent to the NASA Marshall Flight Center, US Army Missile Command, and US Army Strategic Defense Command.

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**Organization:** Alcan Aluminum Limited  
**Component:** ManLabs  
**Address:** 21 Erie St.  
Cambridge, MA 02139  
**Contact:** David Morton  
**Position:** CEO  
**Notes:** Basic applied and product oriented research in metals, alloys, ceramics, and electro-optical materials.

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**Organization:** Alcatel Bell-SDT S.A.  
**Component:**  
**Address:** 101, rue Chapelle Beaussart  
6032 Mont-Sur-Marchienne BELGIUM  
**Contact:** J.P. Rasquin  
**Position:** Directeur Departement de Defense  
**Notes:** Infrared Systems and Equipment

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**Organization:** Allen Infrared Associates  
**Component:**  
**Address:** RR #1, Box 239K  
Coward, SC 29530  
**Contact:** Lee Allen  
**Position:** Mr.  
**Notes:** active in infrared predictive maintenance

**Organization:** Alliant Techsystems  
**Component:**  
**Address:** 5901 Lincoln Drive  
Edina, MN 55436  
**Contact:** Cathy Rude  
**Position:** Marketing Communications  
**Notes:** Thermal Imaging, Night vision, detectors and sensors

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**Organization:** AlliedSignal Aerospace  
**Component:**  
**Address:** 2525 W. 190th Street  
Torrance, CA 90504  
**Contact:** John V. Alexander  
**Position:** Public Relations  
**Notes:** Thermal IMaging, detectors and sensors,

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**Organization:** Alpha Omega Instruments Corp  
**Component:**  
**Address:** 253 Mansfield Drive, P.O. Box DE  
Norton, MA 02766  
**Contact:** Richard Buonaiuto  
**Position:** Mr.  
**Notes:** Has developed an approach to manufacturing a low cost, two-dimensional array using lead selenide or other resistive type detectors, with a targeted manufacturing cost of under \$500 in quantities

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**Organization:** Alturdyne  
**Component:**  
**Address:** 8050 Armour  
San Diego, CA 92111  
**Contact:** Frank Verbeke  
**Position:** President  
**Notes:** Infrared systems and equipment

**Organization:** Amber Engineering  
**Component:**  
**Address:** 5756 Stonewood Drive  
Goleta, CA 93117  
**Contact:** Stan Laband  
**Position:** Marketing Director  
**Notes:** Participant in DARPA's IRFPA team and producer of InSb used in medium-wave infrared systems.

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**Organization:** American Electronic Laboratories, Inc.  
**Component:**  
**Address:** 305 Richardson Rd., PO Box 552  
Landsdale, PA 19446  
**Contact:** Dr Leon Reibman  
**Position:** CEO  
**Notes:** Diversified R&D and manufacturing organization specializing in state-of-the-art equipment for military and industrial applications, electronic warfare and electronic warfare support measure systems, radar and fire control, antennas, supplies, technical service, system engineering services and manufacturing services.

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**Organization:** American Interplex Corporation Laboratories  
**Component:**  
**Address:** 8600 Kanis Rd.  
Little Rock, AR 72204  
**Contact:** Asa Morton  
**Position:** Pres  
**Notes:** R&D on thermal properties of various metals and metal coatings; research in infrared spectroscopy and monitoring using infrared technologies.

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**Organization:** American Magnetics Inc  
**Component:**  
**Address:** PO Box 2509  
Oak Ridge, TN 37831-2509  
**Contact:**  
**Position:**  
**Notes:** cryogenic equipment

**Organization:** American Risk Management Corp.  
**Component:**  
**Address:** 4807 Rockside Road, Ste 500  
Cleveland, OH 44131  
**Contact:** Ronald Lucier  
**Position:** Mr.  
**Notes:** infrared non-destructive evaluation

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**Organization:** American Telephone and Telegraph  
**Component:** AT&T Bell Labs  
**Address:** 600 Mountain Ave.  
Murray Hill, NJ 07974  
**Contact:** Robert Allen  
**Position:** CEO  
**Notes:** Wide range of research in electronics, focusing on emerging technologies including opto-electronics.

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**Organization:** Amherst Systems, Inc.  
**Component:**  
**Address:** 30 Wilson Road  
Buffalo, NY 14221  
**Contact:** Robert L. Cockrell  
**Position:** Director, Business Development  
**Notes:** Passive and Active electro-optical systems, infrared systems & equipment

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**Organization:** AMOCO Corporation  
**Component:** Solarex Corp  
**Address:** 1335 Piccard Dr.  
Rockville, MD 20850  
**Contact:** John Wohlgemuth  
**Position:** Head of R & D  
**Notes:** Applied R&D including photovoltaic devices and power systems.

**Organization:** Amorphous Materials Inc.  
**Component:**  
**Address:** 3130 Benton Street  
Garland, TX 75042  
**Contact:** A. Ray Hilton  
**Position:** President  
**Notes:** Infrared materials production of CdTe, GaAs, and silicon.

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**Organization:** AMP Incorporated  
**Component:** AMP Technology, Electro-optics Division  
**Address:** PO Box 3608  
Harrisburg, PA 17105-3608  
**Contact:** J Hassan  
**Position:** Vice President for Technology  
**Notes:** Applied and product-oriented research and development on fiber optic, electro-optic, passive, and interconnection devices.

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**Organization:** Amteck  
**Component:**  
**Address:** Paoli, CA  
**Contact:**  
**Position:**  
**Notes:** Development of CdTe arrays for solar applications.

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**Organization:** Anacon Corp.  
**Component:**  
**Address:** 117 S St.  
Hopkinton, MA 01748  
**Contact:** Theodore Prophet  
**Position:** Gmgr  
**Notes:** Applied research on refractometers; chlorine monitors; stack gas monitors; ultra-violet and infrared analyzer.



**Organization:** Andersen Group  
**Component:**  
**Address:** 1280 Blue Hills Ave.  
Bloomfield, CT 06002  
**Contact:** Francis Baker  
**Position:** CEO  
**Notes:** Research and development in photonics, telecommunications and high tech industries.

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**Organization:** Andersen Instruments, Inc.  
**Component:** Nutech Corporation  
**Address:** 2806 Cheek Rd  
Durham, NC 27704  
**Contact:** Reggie Stroupe  
**Position:** Pres  
**Notes:** Applied and product-oriented research in the areas of air pollution sampling, filter systems, electronic sensors and controls, temperature control, chromatography, and laboratory research instruments, medical electronics and mass spectrometry.

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**Organization:** Andorian Cyrogenics Inc  
**Component:**  
**Address:** 26 Farwell Street  
Newtonville, MA 02160  
**Contact:**  
**Position:**  
**Notes:** cyrogenics equipment

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**Organization:** Angstrom Technologies, Inc.  
**Component:**  
**Address:** PO Box 607  
Florence, KY 41042  
**Contact:** Keith Seybald  
**Position:** Melec  
**Notes:** Basic and applied electro-optical vision for robotics and automated guided vehicles; applied and product-oriented research in packaging and material handling vision systems.

**Organization:** Applied Electron Corp.  
**Component:**  
**Address:** 2360 Owen Street  
Santa Clara, CA 95054  
**Contact:** Francis Ziemba  
**Position:** VP  
**Notes:** Product-oriented research in the field of radiation detection, both nuclear and optical, including alpha, gamma, x-ray and radon detection, also near IR to visible optical radiation detection.

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**Organization:** Applied Materials, Inc.  
**Component:**  
**Address:** 3050 Bowers Ave.  
Santa Clara, CA 95054  
**Contact:** James Morgan  
**Position:** President  
**Notes:** Research on chemical vapor deposition and plasma etching processes materials and equipment, with particular emphasis on semiconductor materials, metals and dielectrics for the electronics industry, ion implantation of dopants into silicon and process control equipment.

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**Organization:** Applied Solar Energy corporation  
**Component:**  
**Address:** 15251 E Don Julian Rd.  
City of Industry, CA 91749  
**Contact:** Gerard McLarhon  
**Position:** CEO  
**Notes:** Product oriented R&D of solar laser detector products.

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**Organization:** Arco Solar Inc  
**Component:**  
**Address:** 4650 Adohr Ln., PO Box 6032  
Camarillo, CA 93010  
**Contact:** Charles Gay  
**Position:** Pres  
**Notes:** Advanced and applied research and development of photovoltaic devices and systems. Production continues of square foot panels with Commercial Indium Diselenide (CIS) coated with Cadmium Sulfide. CIS is increasingly viewed as the most promising material for solar power.

**Organization:** Aritech  
**Component:** Aritech Corporation  
**Address:** 1510 Tate Blvd., SE  
Hickory, NC 28603  
**Contact:** David Miller  
**Position:** Gmgr  
**Notes:** Sensor detector and alarm system equipment.

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**Organization:** Arizona State University  
**Component:**  
**Address:**  
**Contact:** M.C. Shaw  
**Position:**  
**Notes:** Co-authored 1983 "Application of Infrared Radiation Measurements in Grinding Studies"

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**Organization:** Arvin Industries, Inc  
**Component:** Franklin Research Center  
**Address:** 2600 Monroe Blvd.  
Norristown, PA 19403  
**Contact:** Charles Stokes  
**Position:** Dir  
**Notes:** Applied research, design, and development in electronic and electrical engineering, including electro-optics.

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**Organization:** Astronautics Corporation of America  
**Component:**  
**Address:** 4115 N. Teutonia  
Milwaukee, WI 53209  
**Contact:** P.D. Zingen  
**Position:** Marketing Coordinator  
**Notes:** Night vision, robotics, security systems, ASW equipment, infrared systems & equipment

**Organization:** AT&T Bell Laboratories  
**Component:**  
**Address:** Murray Hill, NJ 07974  
**Contact:** B.F. Levine  
**Position:** Mr.  
**Notes:**

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**Organization:** ATD, Inc.  
**Component:** Advanced Technology Division  
**Address:** PO Box 566  
Woodinville, WA 90872  
**Contact:** Kenneth Kaylor  
**Position:** COO  
**Notes:** Applied R&D of video instrument systems including high-speed, IR microscopic and related research.

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**Organization:** Atlantic Research Canada, Inc.  
**Component:**  
**Address:** 1900 City Park Drive, Suite 400  
Gloucester, Ontario CANADA K1J 1A3  
**Contact:** Tony Canning  
**Position:** Mr.  
**Notes:** Thermal Imaging

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**Organization:** Atomergic Chemetals Corporation  
**Component:**  
**Address:** 222 Sherwood Avenue  
Farmingdale, NY 11735  
**Contact:** M. Hollander  
**Position:** National Sales Manager  
**Notes:** Material processing of CdTe, GaAs, Germanium, Silicon, ZnS, and ZnSe.

**Organization:** Auburn University  
**Component:**  
**Address:**  
**Contact:** P. Banerjee  
**Position:**  
**Notes:** Co-authored 1991 "Weld Quality Control in Gas Tungsten Arc Welding Process"

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**Organization:** Auburn University  
**Component:** Materials Engineering Dept  
**Address:** 201 Ross Hall  
Auburn, AL 36849-5351  
**Contact:** Brian Chin  
**Position:**  
**Notes:** active in infrared process control

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**Organization:** Aurora Technologies Corp.  
**Component:**  
**Address:** San Diego, CA 92121-2410  
**Contact:** F.P. Doty  
**Position:** Mr.  
**Notes:** Co-authored for 1991 MCT Workshop "Properties of CdZnTe Crystals Grown by a High Pressure Bridgman Method"

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**Organization:** Automatic Switch Co  
**Component:**  
**Address:** 50-60 Hanover Road  
Florham Park, NJ 07932  
**Contact:**  
**Position:**  
**Notes:** cryogenic equipment

**Organization:** AUTOMETRIC, INC.  
**Component:**  
**Address:** 5301 SHAWNEE ROAD  
ALEXANDRIA, VA 22312  
**Contact:** DAVID K. GORDON  
**Position:** MR.  
**Notes:** ACTIVE IN INFRARED REMOTE SENSING

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**Organization:** Avimo USA, Inc.  
**Component:**  
**Address:** 716 S Milwaukee Ave.  
Wheeling, IL 91702  
**Contact:** Brad Doetzel  
**Position:** CEO  
**Notes:** Product oriented research in night vision optics and custom optical components, used mainly by the military.

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**Organization:** Baird Infrared Technology, Inc.  
**Component:**  
**Address:** 110 South Poplar Street #310  
Wilmington, DE 19801-5046  
**Contact:** George S. Baird  
**Position:** Mr.  
**Notes:** active in infrared predictive maintenance

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**Organization:** Baker Hughes, Inc.  
**Component:** TN Technology, Inc.  
**Address:** PO Box 800, Round Rock  
TX 78680-0800  
**Contact:** Dr John Nelson  
**Position:** VP  
**Notes:** Applied R&D of radiation detectors and sources, acoustical transducers, and measurements and data processing methodology directed toward the development of instrumentation for the measurement of industrial process parameters.

**Organization:** Ball Electro-Optics and Cryogenics Div.  
**Component:**  
**Address:** P.O. Box 1062  
Boulder, CO 80306  
  
**Contact:** Terry Fleener  
**Position:** Manager, Business Development  
**Notes:** Thermal Imaging, Active and Passive EO systems

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**Organization:** BASF Corporation  
**Component:** Coatings Technical Center  
**Address:** 26701 Telegraph  
Southfield, MI 48034  
  
**Contact:** A.C. Ramamurphy  
**Position:**  
**Notes:** infrared non-destructive evaluation

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**Organization:** Batelle Memorial Institute  
**Component:** Electronic Systems  
**Address:** 505 King Ave.  
Columbus, OH 43201  
  
**Contact:** James Sorenson  
**Position:** General Manager  
**Notes:** Advanced development and integration of complex electronic and optical systems; development of large laser materials for interaction studies; automated inspection systems and optical systems for tracking reentry vehicles.

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**Organization:** Bath Electrical Systems  
**Component:**  
**Address:** 5009 N Hwy 288 B, PO Box 198  
Clute, TX 77531  
  
**Contact:** Thomas Soderman  
**Position:** Pres  
**Notes:** Design and development of systems for infrared scanning for energy losses problems.

**Organization:** Battelle Memorial Institute  
**Component:**  
**Address:** 505 King Avenue  
Columbus, OH 43201-2693  
**Contact:** Milton Seiler  
**Position:** Mr.  
**Notes:** infrared non-destructive evaluation

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**Organization:** BDM Federal, Inc.  
**Component:**  
**Address:** 1501 BDM Way  
McLean, VA 22102-3204  
**Contact:** Duncan Campbell  
**Position:** Corp. V.P.  
**Notes:** Thermal Imaging, imaging software

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**Organization:** BEI Electronics Company, Inc.  
**Component:** BEI Defense Systems Company, Inc.  
**Address:** 11312 S Pipeline Rd., PO Box 155429  
Fort Worth, TX 76155  
**Contact:** Michael Florimbi  
**Position:** CEO  
**Notes:** Product-oriented research, development, testing and evaluation on photoelectric shaft position encoders.

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**Organization:** Belov Technology Co. Inc.  
**Component:**  
**Address:** 345 Sandford Street  
New Brunswick, NJ 07891  
**Contact:** Valery Belov  
**Position:** President  
**Notes:** Manufactures MCT, DTGS, TGS pyroelectric detectors and detector electronic systems, and multi-element arrays. MCT room temperature detectors. Related components.



**Organization:** Bertram Laboratories, Inc.  
**Component:**  
**Address:** 72 Readington Road  
Somerville, NJ 08876  
**Contact:** Leslie G. Polgar  
**Position:** Vice President  
**Notes:**

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**Organization:** Bethlehem Steel Corporation  
**Component:** Homer Research Laboratories  
**Address:** Bethlehem, PA 18016  
**Contact:** Dr. Malcom Roberts  
**Position:** Dirres  
**Notes:** Investigation on new methods of measurement and instrumentation used in the control of steel processes and product quality.

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**Organization:** BHP Research  
**Component:** Melbourne Laboratories  
**Address:** P.O. Box 264  
Clayton, 3168, AUSTRALIA  
**Contact:** H. Buskes  
**Position:** Mr.  
**Notes:** Co-authored for 1992 MCT Workshop "In-Sity Ellipsometric Measurements of the MBE Growht of CdTe/HgTe and CdTe/ZnTe Superlattices"

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**Organization:** Bio-Rad Laboratories  
**Component:** Sadtler Research Laboratories  
**Address:** 3316 Spring Garden St.  
Philidelphia, PA 19104  
**Contact:** Richard Shaps  
**Position:** Dvmgr  
**Notes:** Raman and infrared spectroscopy.

**Organization:** BMA Inc  
**Component:**  
**Address:** PO Box 562  
31 Willows Road  
Ayer, MA 01432  
**Contact:**  
**Position:**  
**Notes:** cryogenic equipment

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**Organization:** Bobbit Laboratories  
**Component:** Viggo-Spectramed  
**Address:** 1900 Williams Dr.  
Oxnard, CA 93030  
**Contact:** Michael Magers  
**Position:** Dirc  
**Notes:** Instrumentation and precise measurement using advanced systems, including infrared sensors.

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**Organization:** Boston Electronics Corp.  
**Component:**  
**Address:** 72 Kent Street  
Brookline, MA 02146  
**Contact:**  
**Position:**  
**Notes:** Manufacture and use of germanium and silicon.

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**Organization:** Brimrose Corporation of America  
**Component:**  
**Address:** 5020 Campbell Blvd  
Baltimore, MD 21236  
**Contact:** John Kasprzak  
**Position:** Marketing Director  
**Notes:**

**Organization:** Brooklyn College  
**Component:** Semiconductor Institute  
**Address:** Brooklyn, NY  
**Contact:** Fred H. Pollak  
**Position:** Dr.  
**Notes:** Former director of the SPIE

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**Organization:** Brown Group, Inc.  
**Component:** Research and Development Laboratory  
**Address:** 8400 Maryland Ave.  
Saint Louis, MO 63166  
**Contact:** Lloyd Brunkhorst  
**Position:** VPeng  
**Notes:** Basic research for new manufacturing processes.

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**Organization:** Brown University  
**Component:**  
**Address:** Providence, RI  
**Contact:** Donald E. McClure  
**Position:**  
**Notes:** AUthored "Image Acquisition and Processing Equipment for Machine Vision" September 1990

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**Organization:** Brunson Instrument Co, Inc  
**Component:**  
**Address:** 800 E 23rd PO Box 7951  
Kansas City, MO 64129  
**Contact:** Gary Powell  
**Position:** Dreng  
**Notes:** Research, design, and development in the optical mechanical and electro-optical field, circular and linear developing.

**Organization:** Brunswick Technical Group  
**Component:**  
**Address:** 1 Brunswick Plaza  
Skokie, IL 60077  
**Contact:** Diane R. Sheerar  
**Position:** Manager Marketing Services  
**Notes:** Infrared Systems and Equipment

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**Organization:** BSA Technology, Inc.  
**Component:**  
**Address:** 3812 Sepulveda Blvd, Ste 500  
Torrance, CA 90505  
**Contact:**  
**Position:**  
**Notes:**

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**Organization:** Buck Werke GMBH & Co.  
**Component:**  
**Address:** Hans-Buck-Strasse 1  
D-7844 Neuenburg, GERMANY  
07631  
**Contact:** Walter Hanser  
**Position:** Marketing Director  
**Notes:** Services, Infrared Systems and Equipment

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**Organization:** Burleigh Instruments, Inc  
**Component:**  
**Address:** Burleigh Park  
Fishers, NY 14453-9999  
**Contact:**  
**Position:**  
**Notes:**

**Organization:** Burleigh Instruments, Inc.  
**Component:**  
**Address:** Burleigh Park  
Fishers, NY 14453  
**Contact:** Ronald Autos  
**Position:** drR&D  
**Notes:** Product oriented research in lasers, optical equipment, and micropositioning equipment.

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**Organization:** California Institute of Technology  
**Component:**  
**Address:** CA  
**Contact:** R.W. Capps  
**Position:**  
**Notes:** Co-authored for 1990 IEEE Meeting on Advanced IR Detectors "Space Science Applications of Infrared Detector Technology: A Review"

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**Organization:** California Institute of Technology  
**Component:** Jet Propulsion Laboratory  
**Address:** Pasadena, CA 91109  
**Contact:** Anthony C. Ibbott  
**Position:** Mr.  
**Notes:** active in infrared remote sensing

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**Organization:** California Institute of Technology  
**Component:** Jet Propulsion Laboratory  
**Address:** 4800 Oak Grove Drive  
Pasadena, CA 91009-8099  
**Contact:** Marija S. Scholl  
**Position:**  
**Notes:** Editor of upcoming January 1994 edition of the SPIE's Optical Engineering journal, focusing on infrared technology.

**Organization:** Cambridge University  
**Component:** Cavendish Lab  
**Address:** Cambridge, UNITED KINGDOM  
**Contact:** T.D. Golding  
**Position:**  
**Notes:** Co-authored October 1988 "MBE of HgCdTe"

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**Organization:** Carl Zeiss  
**Component:**  
**Address:** Sondertechnik  
Postfach 1380  
7082 Oberkochen, GERMANY  
**Contact:** Peter Albers  
**Position:** Sales Manager  
**Notes:** Thermal Imaging, Detectors and Sensors, Night Vision

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**Organization:** Carnegie-Mellon University  
**Component:** Robotics Institute  
**Address:** Pittsburgh, PA  
**Contact:** C. Caillas  
**Position:**  
**Notes:** Authored an April 1990 study, 100 pages, on "Thermal Imaging for Robotic Applications in Outdoor Scenes"

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**Organization:** CEI Technologies, PTE Ltd.  
**Component:**  
**Address:** 249 Jalan Boon Lay  
Singapore 2261  
**Contact:** Toh Kim-Huat  
**Position:** V.P./ General Manager  
**Notes:** Thermal imaging, night vision

**Organization:** Cerac Inc.  
**Component:**  
**Address:** Milwaukee, WI  
**Contact:**  
**Position:**  
**Notes:** Manufacturer of infrared materials.

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**Organization:** Channel Technologies  
**Component:** Electro-optical Industries, Inc.  
**Address:** 859 Ward Dr.  
Santa Barbara, CA 93111  
**Contact:** Arthur Cussen  
**Position:** Pres  
**Notes:** Research on infrared and visible blackbody radiant energy standards, radiometry, electro-optical instrumentation, microwave standards, low-level instrumentation, industrial temperature measurement, and radiation thermometry.

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**Organization:** Chemring, Ltd.  
**Component:**  
**Address:** Alchem Works  
Fratton Trading Estate  
Portsmouth, Hampshire, ENGLAND PO4 8SX  
**Contact:** David Radford  
**Position:** Marketing Director  
**Notes:** Infrared Systems & Equipment, passive EO systems

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**Organization:** CIC International, Ltd.  
**Component:**  
**Address:** 38-01 23rd Avenue  
Astoria, NY 11105  
**Contact:** James Chladek  
**Position:** Vice President  
**Notes:** Detectors and Sensors, infrared systems and equipment, night vision equipment

**Organization:** Cincinatti Electronics  
**Component:**  
**Address:** 7500 Innovation Way  
Mason, OH 45040-9699  
**Contact:** Tom Venable  
**Position:** Marketing Manager for IR Detectors  
**Notes:** Manufactures and designs IR detectors including single-element, linear and two dimensional arrays, discrete channel amplified, multiplexed, in Ge, MCT, InSb and InAs, 1-12 um.

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**Organization:** Claflin College  
**Component:** Department of Mathematics and Physics  
**Address:** Orangeburg, South Carolina 29115  
**Contact:** Sylvester N. Ekpenuma  
**Position:**  
**Notes:** Co-authored for 1991 MCT Workshop "Critical Stress of HgCdTe Solid Solutions" and "Microhardness of Hg-Containing II-VI Alloys"

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**Organization:** Clarkson University  
**Component:**  
**Address:** Potsdam, NY 13699  
**Contact:** Frederick M. Carlson  
**Position:** Mr.  
**Notes:** Attended 1992 MCT conference

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**Organization:** Cleveland Crystals, Inc.  
**Component:**  
**Address:** 19306 Redwood Avenue, P.O Box 17157 Cleveland, OH 44117  
**Contact:** Peter Direnzo  
**Position:** Gnl Mgr  
**Notes:** Manufacturer and research into CdTe, ZnS, and ZnSe infrared materials.



**Organization:** CMTEK Pty, Ltd  
**Component:**  
**Address:** P.O. Box 1500  
Salisbury 5108, South Australia  
**Contact:** M.A. Folkard  
**Position:** Mr.  
**Notes:** Co-authored for 1992 MCT Workshop "In-Situ Ellipsometric Measurements of the MBE Growth of CdTe/HgTe and CdTe/ZnTe Superlattices"

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**Organization:** CNRS  
**Component:** Laboratoire de Physique des Solides de Bellevue  
**Address:** F-92195 Meudon-Cedex, FRANCE  
**Contact:** Y. Marfaing  
**Position:**  
**Notes:** Authored for 1991 MCT Workshop "Point Defects and Defect-Purity Interaction of CdHgTe and Other II-VI Semiconductors: Facts and Conjectures."

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**Organization:** Cochise Instruments Inc  
**Component:**  
**Address:** 6304 De Mello Street  
Hereford, AZ 85615  
**Contact:**  
**Position:**  
**Notes:** cryogenic equipment

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**Organization:** Codenoll Technology Corporation  
**Component:**  
**Address:** Yonkers, NY  
**Contact:**  
**Position:**  
**Notes:** Development of InP sensors for use in optical transmitters and receivers in cooperation with NYNEX.

**Organization:** College of William and Mary  
**Component:** Dept of Physics  
**Address:** Williamsburg, VA 23185  
**Contact:** Christopher S. Welch  
**Position:** Mr.  
**Notes:** infrared non-destructive evaluation

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**Organization:** Colorado Research Lab  
**Component:**  
**Address:** Walsenburg, CO  
**Contact:** Maruice J. Brau  
**Position:**  
**Notes:** Authored January 1991 report "Ultra-high-purity Starting Materials for Infrared Detector Crystal Growth"  
  
and January 1991 "Traveling Heater Method Growth of Bulk Compound Semiconductor Alloy Crystals"

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**Organization:** Columbia University  
**Component:**  
**Address:** New York, NY  
**Contact:** E.R. Fossum  
**Position:**  
**Notes:** Co-authored for 1990 SPIE workshop on IR Detectors "GaAs CCD Readout for Engineered Bandgap Detectors"

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**Organization:** Commerical Crystal Laboratories, Inc.  
**Component:**  
**Address:** 4406 Arnold Avenue  
Naples, FL 33942  
**Contact:**  
**Position:**  
**Notes:** Manufacturer of CdTe, GaAs, silicon, ZnS, and ZnSe.

**Organization:** Commonwealth Scientific Corp  
**Component:**  
**Address:** 500 Pendleton Street  
Alexandria, VA 22314  
**Contact:**  
**Position:**  
**Notes:** cryogenic equipment

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**Organization:** Compaq Computer  
**Component:**  
**Address:**  
**Contact:** Greg Haug  
**Position:** Mr.  
**Notes:**

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**Organization:** Computing Devices Co.  
**Component:**  
**Address:** Castleham Road  
St. Leonards on Sea  
East Sussex, UK TN389NJ  
**Contact:** Mike Turley  
**Position:** Marketing Director  
**Notes:** Infrared systems and Equipment

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**Organization:** Concept Engineering  
**Component:**  
**Address:** 43 Ragged Rock Rd.  
Old Saybrook, CT 06475  
**Contact:** Ludwig Holtermann  
**Position:** owner  
**Notes:** IR-technology sensor and detector development.

**Organization:** Continental Optical Corp.  
**Component:**  
**Address:** 15 Power Drive  
Hauppauge, NY 11788  
**Contact:** Manfred W. Grindel  
**Position:** President  
**Notes:** Manufacturer of silicon, ZnS, and ZnSe infrared materials.

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**Organization:** Contraves USA  
**Component:** Boston Electro Optic Division  
**Address:** 170 Locke Dr.  
Marlborough, MA 01752  
**Contact:** Max Riedl  
**Position:** CEO  
**Notes:** Applied research on electrical-optical systems, instruments and components utilizing infrared, visible and ultraviolet spectrums, including infrared detectors, optical elements, and optical interference and coatings filters, radiation sources, radiometers, combustion analyzers, navigation instruments for satellites and spacecraft and sensors for meteorological satellites; chemical and drug detection, instrumentation, target and scene simulation, models, gas detection, measurement instrumentation.

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**Organization:** Cornell University  
**Component:** School of Electrical Engineering and the National Nanofabrication Facility  
**Address:** Ithaca, NY 14853  
**Contact:** Y. Shacham-Diamand  
**Position:**  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "P-Channel MIS Double-Metal Process InSb Monolithic Unit Cell for Infrared Imaging"

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**Organization:** Cox & Company, Inc.  
**Component:**  
**Address:** 200 Varick St.  
New York, NY 10014  
**Contact:** Warren Achenbaum  
**Position:** Pres  
**Notes:** Electronic and mechanical engineering, aerodynamics, thermal engineering.

**Organization:** Crane Co  
**Component:** Hydro-Aire Division  
**Address:** 3000 Winona Ave.  
Burbank, CA 91504  
**Contact:** JD Tarbet  
**Position:** VPeng  
**Notes:** Infrared tracking for wind shear detection and high response control synthesis for extra fast control systems.

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**Organization:** Craver & Craver Inc  
**Component:**  
**Address:** 761 W Kirkham Ave.  
Saint Louis, MO 63122  
**Contact:** Dr Clara Craver  
**Position:** COO  
**Notes:** Computer-assisted database searches in infrared spectroscopy; reference spectra for IR.

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**Organization:** Cray Research  
**Component:**  
**Address:** 925 First Avenue  
Chippewa Falls, WI 54729-1402  
**Contact:** Christine Anderson  
**Position:** Ms.  
**Notes:** active in infrared process control

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**Organization:** Crystal Specialties International  
**Component:**  
**Address:** 2853 Janitall Road  
Colorado Springs, CO 80906  
**Contact:** Kelly Burke  
**Position:** Operations Manager  
**Notes:** Production of GaAs and germanium for infrared applications.

**Organization:** Crystal Systems Inc.  
**Component:**  
**Address:** Shetland Industrial Park  
27 Congress St.  
Salem, MA 01970  
**Contact:** Frederick Schmid  
**Position:** CEO  
**Notes:** Growth of semiconductors using such materials as GaAs and CdTe, and use of silicon in infrared applications

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**Organization:** CVS Systems & Services, Inc.  
**Component:** CVD Systems & Services  
**Address:** Penn Centre Plaza  
Quakertown, PA 18951  
**Contact:** Warner Whitmer  
**Position:** Pres  
**Notes:** Production of solar cells and sensor prototyping.

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**Organization:** Daedalus Enterprises, Inc.  
**Component:**  
**Address:** 300 Parkland Plaza, PO Box 1869  
Ann Arbor, MI 48106  
**Contact:** Charles G Stanich  
**Position:** Vice President  
**Notes:** Infrared and multispectral analysis.

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**Organization:** DALSA Inc, CCD Image Sensors  
**Component:**  
**Address:** 605 McMurray Road  
Waterloo, Ontario CANADA N2V 2E9  
**Contact:**  
**Position:**  
**Notes:**

**Organization:** Datametrics Corp.  
**Component:**  
**Address:** 8986 Comanche Avenue  
Chatsworth, CA 91311  
**Contact:** Betty Blodgett  
**Position:** Marketing  
**Notes:** Thermal Imaging

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**Organization:** Datron Systems, Inc.  
**Component:**  
**Address:** 200 W Los Angeles Ave.  
Simi Valley, CA 93065-1650  
**Contact:** Dave Derby  
**Position:** Pres  
**Notes:** Production and research in infrared optical and laser sensors.

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**Organization:** David Sarnoff Research Center  
**Component:**  
**Address:** CN5300 Washington Road  
Princeton, NJ 08543-5300  
**Contact:** John R. Tower  
**Position:** Manager, Visible and IR Imaging Business  
**Notes:**

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**Organization:** Davin Optical, Ltd.  
**Component:**  
**Address:** 9A Chester Road  
Borehamwood, Herts, UK WD6 1LD  
**Contact:** David Holland  
**Position:** Managing Director  
**Notes:** Night Vision, EO Systems, Infrared Systems and Equipment, Thermal Imaging

**Organization:** DBA Systems, Inc.  
**Component:**  
**Address:** P. O. Box 550  
Melbourne, FL 32902  
**Contact:** Darrell Curtis  
**Position:** Director Business Development  
**Notes:** Thermal Imaging, infrared systems and equipment

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**Organization:** Decilog, Inc.  
**Component:**  
**Address:** 555 Broad Hollow Rd  
Melville, NY 11747-5093  
**Contact:** John Marchesano  
**Position:** President  
**Notes:** Technical support to government and industry in infrared systems and components.

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**Organization:** Decision Images, Inc  
**Component:**  
**Address:** 196 Tamarack Circle  
Skillman, NJ 08558  
**Contact:**  
**Position:**  
**Notes:** remote sensing systems, thermal infrared, multispectral

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**Organization:** Delco Electronics  
**Component:**  
**Address:** 700 East Firman Avenue  
Kokomo, IN 46901  
**Contact:** Bill Bauson  
**Position:** Mr.  
**Notes:** active in infrared non-destructive evaluation



**Organization:** Delta International, Inc.  
**Component:**  
**Address:** 2111 Wilson Boulevard, Suite 700  
Arlington, VA 22201  
**Contact:** Earl Thompson  
**Position:** President  
**Notes:** Thermal imaginig, detectors and sensors

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**Organization:** Diagnostic Retrieval Systems, Inc.  
**Component:** Photronics Corporation  
**Address:** 270 Motor Pkwy.  
Hauppauge, NY 11788  
**Contact:** Richard Ross  
**Position:** CEO  
**Notes:** Develop and manufacture optical laser ultraviolet detection components,  
missile optical component and specialized coating.

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**Organization:** Diffracto Ltd.  
**Component:**  
**Address:** 2835 Kew Dr.  
Windsor, ON N8T 3B7  
**Contact:** Omer Hageniers  
**Position:** Pres  
**Notes:** Research in vision sensors and gas lasers for measuring purposes.

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**Organization:** Digital Equipment Corp  
**Component:**  
**Address:** Mail Stop MLO5-4/E22  
Maynard, MA 01754  
**Contact:** Edward Cox  
**Position:** Mr.  
**Notes:** infrared non-destructive evaluation

**Organization:** Diversified Optical Products  
**Component:**  
**Address:** 282 Main St.  
Salem, NH 03079  
**Contact:** Lawrence Kessler  
**Position:** Pres  
**Notes:** Automated IR and visible automated MTF testing.

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**Organization:** Dover Corporation  
**Component:** Universal Instrument Corp.  
**Address:** PO Box 825  
Binghamton, NY 13902  
**Contact:** John Pomeroy  
**Position:** Pres  
**Notes:** Automation of electronics industry production.

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**Organization:** Dresden University of Technology  
**Component:** Institut fur Festkorperelektronik  
**Address:** Dresden, FEDERAL REPUBLIC OF GERMAN  
**Contact:** H. Budzier  
**Position:**  
**Notes:** Co-authored for 1992 SPIE IRFPA meeting "Pyroelectric IR Single-Element Detectors and Arrays Based on LiNbO3 and LiTaO3"  
  
Co-authored for 1991 SPIE meeting on Growth of IR Materials "Pyroelectric Linear Array IR Detectors with CCD Multiplexer"

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**Organization:** DRS Photonics Corp  
**Component:**  
**Address:** 270 Motor Parkway  
Hauppauge, NY 11788  
**Contact:** Patricia Williamson  
**Position:** Assistant VP Corp. Comm.  
**Notes:** Electro optical systems, night vision, infrared systems and equipment

**Organization:** DTX Corporation  
**Component:** Dynatherm Corporation  
**Address:** One Beaver Ct.  
Cockeysville, MD 21030  
**Contact:** Edward Scicchitano  
**Position:** CEO  
**Notes:** Thermal systems research oriented toward industrial process temperature control.

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**Organization:** Dukane Corporation  
**Component:** Microbiotics Division  
**Address:** 2900 Dukane Dr.  
Saint Charles, IL 60174  
**Contact:** JM Stone  
**Position:** Pres  
**Notes:** Precision automated alignment and laser welding systems used to manufacture optoelectronic devices.

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**Organization:** Dynamics Research Corporation  
**Component:**  
**Address:** 60 Concord St.  
Wilmington, MA 01887  
**Contact:** Albert Rand  
**Position:** Pres  
**Notes:** Design and fabrication of optical digital shaft angle encoders for aerospace and industrial applications.

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**Organization:** Dynatech Corporation  
**Component:** Sensors, Inc.  
**Address:** 6812 S State Rd  
Saline MI 48176  
**Contact:** Tom Fournier  
**Position:** President  
**Notes:** Commercial uses for infrared technology.

**Organization:** E-Systems, Inc.  
**Component:** HRB Systems, Inc  
**Address:** 300 Science Park Rd.  
State College, PA 16804  
**Contact:** Michael Keebaugh  
**Position:** Pres  
**Notes:** Integration of sensors into systems capable of military surveillance missions.

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**Organization:** E2 Technology corp.  
**Component:**  
**Address:** 4475 Dupont Ct., No 9  
Ventura, CA 93003  
**Contact:** Earnest Emery  
**Position:** CEO  
**Notes:** Product oriented research in infrared blackbodies

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**Organization:** Eagle-Picher Industries, Inc.  
**Component:**  
**Address:** P.O.Box 737  
Quapaw, OK 74363  
**Contact:** Brian McLain  
**Position:** Sales Manager  
**Notes:** High Purity infrared materials

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**Organization:** Eastman Chemical Co  
**Component:** Eastman Laboratory Chemicals  
**Address:** 1001 Lee Road  
Rochester, NY 14652-3512  
**Contact:**  
**Position:**  
**Notes:**

**Organization:** Eastman Kodak Co.  
**Component:** Government Systems Div.  
**Address:** 1447 St. Paul Street  
Rochester, NY 14653  
**Contact:** Rollo Black  
**Position:** Business Development  
**Notes:** IR Detectors work, mostly PtSi.

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**Organization:** Eastman Kodak Company  
**Component:** Kodak Apparatus Division  
**Address:** 901 Elmgrove Rd.  
Rochester, NY 14653  
**Contact:** Lawrence Matteson  
**Position:** Manager  
**Notes:** Applied research in physics and engineering to establish experimental and analytical foundations for new and improved processes in electro, photo-optical, and mechanical products. Additional research with PtSi under a contract from the Air Force Aeronautical Systems Division for use in adverse weather landing systems.

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**Organization:** EDO Corporation  
**Component:** Barnes Engineering Company  
**Address:** 88 Long Hill Cross Rd.  
Shelton, CT 06484  
**Contact:** Frank Fariello  
**Position:** Pres  
**Notes:** Product oriented research in infrared sensors.

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**Organization:** EEV Ltd.  
**Component:**  
**Address:** Waterhouse Lane  
Chelmsford, Essex ENGLAND CM1 2QU  
**Contact:** David Taylor  
**Position:** Sales Manager  
**Notes:** Active and passive co systems, infrared systems and equipment, night vision.

**Organization:** EG & Mound Applied Technology  
**Component:**  
**Address:** Box 3000  
Manisburg, OH 45342  
**Contact:** Jonathan H. Mohler  
**Position:** Mr.  
**Notes:** active in infrared remote sensing

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**Organization:** EG&G Princeton Applied Research  
**Component:**  
**Address:** 375 Phillips Boulevard  
Trenton, NJ 08618  
**Contact:** S.E. Mohr  
**Position:** Mr.  
**Notes:** Co-authored for 1992 SPIE Workshop on IRFPAs "Popcorn Noise in Linear InGaAs Detector Arrays"

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**Organization:** EG&G Reticon Corp.  
**Component:**  
**Address:** 345 Potrero Avenue  
Sunnyvale, CA 94086-4197  
**Contact:** John Skurla  
**Position:** Sales Manager  
**Notes:**

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**Organization:** EG&G, Inc.  
**Component:** EG&G Judson  
**Address:** 221 Commerce Dr.  
Montgomeryville, PA 18936  
**Contact:** Andrew Allen  
**Position:** VP Sales  
**Notes:** Application of infrared materials including germanium and mercury cadmium telluride.

**Organization:** Elbit Systems, Inc.  
**Component:**  
**Address:** 16 Esquire Road  
North Billerica, MA 01862  
**Contact:** Joseph A. Parini  
**Position:** President  
**Notes:** EO systems, infrared systems and equipment, night vision

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**Organization:** Electric Power Research Institute  
**Component:**  
**Address:** 3 Industrial Highway  
Eddystone, PA 19022  
**Contact:** Robert G. Hammaker  
**Position:** Mr.  
**Notes:** active in infrared predictive maintenance

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**Organization:** Electro Optical Industries, Inc  
**Component:**  
**Address:** 859 Ward Drive  
Santa Barbara, CA 93111  
**Contact:**  
**Position:**  
**Notes:**

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**Organization:** Electronic Devices, Inc.  
**Component:**  
**Address:** Urbana, IL  
**Contact:**  
**Position:**  
**Notes:** Participated in DARPA's initial Electronic Services HgCdTe program.

**Organization:** Electronic Space Products International (ESPI)  
**Component:**  
**Address:** 5310 Derry Avenue  
Agoura Hills, CA 91301  
**Contact:**  
**Position:**  
**Notes:** Manufacture and application of CdTe, GaAs, germanium, ZnS, and ZnSe infrared systems.

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**Organization:** Electrophysics  
**Component:**  
**Address:** 373 Route 46 West, Building E  
Fairfield, NJ 07004  
**Contact:** Frank J. Vallesco  
**Position:** General Manager  
**Notes:** Night Vision, thermal imaging

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**Organization:** Elettronica S.p.A.  
**Component:**  
**Address:** via Tiburtina KM 13.7  
1-00131 Rome, ITALY  
**Contact:** Camillo Pariset  
**Position:** P.R. Manager  
**Notes:** Infrared systems and equipment

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**Organization:** Elop-Electro Optics Industries  
**Component:**  
**Address:** P.O. Box 1165  
Rehovot, Israel 76110  
**Contact:** Tuvia Charmey  
**Position:** Advertising Manager  
**Notes:** Infrared systems and equipment, thermal imaging, detectors and sensors, night vision



**Organization:** Emcore Corp.  
**Component:**  
**Address:** 35 Elizabeth Avenue  
Somerset, NJ 08873  
**Contact:** William J. Burns  
**Position:** President  
**Notes:** Material production of GaAs, CdTe, silicon, ZnS, and ZnSe for infrared applications.

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**Organization:** Emerson Electric Co  
**Component:** Rosemount Inc.  
**Address:** 12001 technology Dr.  
Eden Prairie, MN 55344  
**Contact:** Robert Cox  
**Position:** President  
**Notes:** Applied research on sensors and instruments for measurements of temperature, flow level, pressure, and other industrial applications.

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**Organization:** Entec  
**Component:**  
**Address:** Suite 100, 2817 Garden Hwy  
Sacramento, CA 95833  
**Contact:** Robert Ngyen  
**Position:** COO  
**Notes:** Basic research in photovoltaics.

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**Organization:** EnTech Engineering, Inc.  
**Component:**  
**Address:** 111 Marine Lane  
St. Louis, MO 63146  
**Contact:** Leann M. Forister  
**Position:** Ms.  
**Notes:** active in infrared remote sensing

**Organization:** Enterprise for Semiconductor Devices  
**Component:**  
**Address:** ROMANIA  
**Contact:** M.N. Udrea-Spenca  
**Position:**  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Accurate Method for Neutron Fluence Control Used in Improving Neutron-Transmutation-Doped Silicon Detectors"

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**Organization:** Environmental Technology Group, Inc.  
**Component:**  
**Address:** 1400 Taylor Ave., PO Box 9840  
Baltimore, MD 21284-9840  
**Contact:** John Spelman  
**Position:** Pres  
**Notes:** Applied research in detectors for explosives, hazardous drugs and chemical warfare agents.

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**Organization:** Environmetrics, Inc.  
**Component:**  
**Address:** 2345 Millpark Dr.  
Maryland Heights, MO, 63043  
**Contact:** Dr Eugene Scheide  
**Position:** Pres  
**Notes:** Development of "smart sensors," interest in using IR, esp. sensitive MCT variety

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**Organization:** EOIS  
**Component:**  
**Address:** Suite 501, 710 Wilshire Blvd.  
Santa Monica, CA 90401  
**Contact:** John Fitts  
**Position:** Pres  
**Notes:** Smart sensor technology development.

**Organization:** EPI Crystal Supplies Pty, Ltd.  
**Component:**  
**Address:** Monbulk, Victoria, 3793 Australia  
**Contact:** G.N. Pain  
**Position:** Mr.  
**Notes:** Authored for 1991 MCT Workshop "Effects of mixed-valence Mercury and Indium on the Electrical Properties of HgCdTe"

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**Organization:** EPIR, Ltd.  
**Component:**  
**Address:** Oak Brook, IL 60521  
**Contact:** P.S. Wijewarnasuriha  
**Position:** Mr.  
**Notes:** Co-authored for 1992 MCT Workshop "Influence of CdZnTe (211)B Substrate on Electrical Properties of HgCdTe Grown by MBE"

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**Organization:** Epitaxx, Inc.  
**Component:**  
**Address:** 3490 Route 1,  
Princeton, NJ 08540  
**Contact:** Ken Fujiwara  
**Position:** President  
**Notes:** Long-wavelength high speed sources and detectors for fiberoptic communications (InGaAs photodiodes, 1300 & 1500 nm edge LED and laser diode), large area InGaAs detectors for test and measurement rangefinding. Develops 512 element InGaAs arrays of cutoff wavelengths of 2.6um.

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**Organization:** ERIM - Environmental Research Inst of Michigan  
**Component:**  
**Address:** PO Box 8618  
Ann Arbor, MI 48107-8618  
**Contact:**  
**Position:**  
**Notes:** remote sensing systems, thermal infrared, multispectral

**Organization:** ESA-ESTEC  
**Component:**  
**Address:** Keplerlaan 1,  
NL-2200 AZ Noordwijk, THE NETHERLANDS  
**Contact:** Marino Babbricotte  
**Position:** Mr.  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Comparative Study of SWIR and MWIR Schottky-Barrier Imagers."

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**Organization:** Euromissile Dynamics Group  
**Component:** Eltro  
**Address:** Germany  
**Contact:**  
**Position:**  
**Notes:** Produces HgCdTe-based infrared guidance systems for military applications.

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**Organization:** Evans & Sutherland  
**Component:**  
**Address:** 600 Komas Drive  
Salt Lake City, UT 84108  
**Contact:** Jeff Edwards  
**Position:** Communications Manager  
**Notes:** Night Vision, thermal imaging

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**Organization:** Evcy Engineering Co Inc  
**Component:**  
**Address:** 154 Center Street  
Groveland, MA 01834-1016  
**Contact:**  
**Position:**  
**Notes:** cryogenic equipment

**Organization:** Exotech, Inc  
**Component:**  
**Address:** 8502 Dakota Dr.  
Gaithersburg, MD 20877  
**Contact:** Robert Lyle  
**Position:** Pres  
**Notes:** Electro-optical and electronic instrumentation.

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**Organization:** Exotic Materials, Inc,  
**Component:**  
**Address:** 2930 Bristol St.  
Costa Mesa, CA 92626  
**Contact:** Roderick R. Randolph  
**Position:** Sales Manager  
**Notes:** Applied, product-oriented research as related to electro-optical materials, vacuum deposited coatings and devices for government, industrial and military systems applications.

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**Organization:** Fermionics  
**Component:**  
**Address:** 4555 Runway St.  
Simi Valley, CA 93063  
**Contact:** Peter Wang  
**Position:** CEO  
**Notes:** Produces wholesale CdTe and participant in CECOMs night vision advanced research.

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**Organization:** FIBERTEK, Inc.  
**Component:**  
**Address:** Herndon, VA 22070  
**Contact:** Horacio R. Verdun  
**Position:** Mr.  
**Notes:** Co-authored for 1992 MCT Workshop "Tunnelling Current Probe for Contactless Electrical Performance Measurements of Infrared Focal Plane Detector Arrays"

**Organization:** FJW Optical Systems, Inc  
**Component:**  
**Address:** 629 S Vermont St.  
Palatine, IL 60067  
**Contact:** Edward Wood  
**Position:** President  
**Notes:** Electro-optical systems and infrared viewing devices for production.

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**Organization:** FLIR Systems, Inc.  
**Component:**  
**Address:** 16505 SW 72nd Avenue  
Portland, OR 97224  
**Contact:** Frans Eberth  
**Position:** Mr.  
**Notes:** infrared non-destructive evaluation

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**Organization:** Ford Motor Co.  
**Component:** Scientific Research Laboratory  
**Address:** P.O. Box 2053  
Dearborn, MI 48121  
**Contact:** R.P. Cooper  
**Position:** Mr.  
**Notes:** infrared non-destructive evaluation

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**Organization:** Fraser-Volpe Corporation  
**Component:**  
**Address:** Warminster Industrial Park, 1025 Thomas Dr.  
Warminster PA 18974  
**Contact:** David Fraser  
**Position:** Pres  
**Notes:** Electro-optics and electronic systems; design and development of systems for inspection of fluid-filled vials and other glass containers to detect chips, cracks and foreign particles, stabilization systems for optical viewing devices, television and motion picture cameras, laser stabilization.

**Organization:** Fraunhofer-Institut für Angewandte Festkörperphysik  
**Component:**  
**Address:** Tullastr. 72  
D-7800 Freiburg, Germany  
**Contact:** D.D. Edwall  
**Position:**  
**Notes:** Author of "Characterization of MCT Heterostructures by Thermoelectric Measurements"

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**Organization:** FSI International  
**Component:**  
**Address:** 322 Lake Hazeltine Dr.  
Chaska, MN 55318  
**Contact:** Joel Elftmann  
**Position:** Pres  
**Notes:** Research for semiconductor production equipment.

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**Organization:** FTS Sys Inc  
**Component:**  
**Address:** PO Box 158  
Stone Ridge, NY 12484  
**Contact:**  
**Position:**  
**Notes:** cryogenic equipment

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**Organization:** Fujitsu Laboratories, Ltd.  
**Component:** Atsugi Infrared Devices Laboratory  
**Address:** 10-1 Morinosato-Wakamiya  
Atsugi 243-01 JAPAN  
**Contact:** K. Awamoto  
**Position:** Mr.  
**Notes:** Co-authored for 1992 SPIE Workshop on IRFPAs "Resolution Improvement for HgCdTe IRCCD"

**Organization:** Future Technology Services  
**Component:**  
**Address:** 700 Indian Trail Road  
Atlanta, GA 30247  
**Contact:**  
**Position:**  
**Notes:** Prepared a study on the potential IR thermography market in 1988.

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**Organization:** Galileo Electro-Optics Corp.  
**Component:**  
**Address:** Galileo Park, PO Box 550  
Sturbridge, MA 01566  
**Contact:** William Hanley  
**Position:** CEO  
**Notes:** Develops fiber-optic and electro-optic components which transmit, intensify or sense light images.

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**Organization:** Galtech Semiconductor Materials Corp.  
**Component:**  
**Address:** 265 North State Street  
Mt. Pleasant, UT 84647  
**Contact:** Melvin J. Carr  
**Position:** President  
**Notes:** Manufacture of CdTe infrared materials, germanium, wafers and ingots, monocrystalline and polycrystallins. Polishing and slicing series for CdTe and CdZnTe.

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**Organization:** GE Aerospace  
**Component:** Electronics Lab  
**Address:** Syracuse, NY  
**Contact:** Bob Yanka  
**Position:**  
**Notes:** Scientist working on MBE, past work on advanced iRFPA concepts for WRight Patterson AFB April 1987-DeCember 1990



**Organization:** GEC Ferranti  
**Component:**  
**Address:** Ferry Road  
Edinburgh, Scotland EH5 2XS  
  
**Contact:** John Ford  
**Position:** Public Relations Manager  
**Notes:** night vision, detectors and sensors, active and passive EO systems

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**Organization:** GEC Ferranti Defence Systems, Ltd.  
**Component:**  
**Address:** Navigation and Electro Optics Division  
Silverknowes, Ferry Road  
Edinburgh, UK EH4 4AD  
  
**Contact:** F.J. Graham  
**Position:** Marketing Support Exec  
**Notes:** Infrared systems and equipment, night vision e/o systems

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**Organization:** GEC Hirst Research Centre  
**Component:**  
**Address:** Wembley, UNITED KINGDOM  
**Contact:** L.M. Smith  
**Position:** Mr.  
**Notes:** Co-authored May 1990 report "Integrated Technology in MCT/GaAs and MCT/Si for Medium and Long Wavelength Infrared"

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**Organization:** GEC Marconi Dynamics, Ltd.  
**Component:**  
**Address:** The Grove  
Warren Lane  
Stanmore, Middlesex, UK HA7 4LY  
  
**Contact:** R. Coltart  
**Position:** Press Officer  
**Notes:** infrared systems and equipment, MMW radar, etc.

**Organization:** GEC Sensors  
**Component:** Hirst Infrared Division  
**Address:** East Lane,  
Wembley, Middlesex, HA9 7PP, UK  
**Contact:**  
**Position:**  
**Notes:** Production of a wide variety of HgCdTe-based systems, including sensors for the Tornado, Harrier, and Lynx. Most HgCdTe material is purchased from Philips. The company also has invested heavily in internal research on InSb and dual-wave band sensor technology.

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**Organization:** General Dynamics  
**Component:** Space Systems Division  
**Address:** 2945 Arcola Avenue  
San Diego, CA 92117  
**Contact:** Douglas Burleigh  
**Position:** Mr.  
**Notes:** active in infrared remote sensing, predictive maintenance, non-destructive evaluation

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**Organization:** General Dynamics Corporation  
**Component:** Electronics Division  
**Address:** 5011 Kearny Villa Rd.  
San Diego, CA 92123-1447  
**Contact:** Terry Straetten  
**Position:** Vice President  
**Notes:** Product oriented research in automatic test equipment and electronics, communications, electronic warfare, signal processing, and displays and imagery, lasers.

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**Organization:** General Electric Company  
**Component:** Aerospace Electronics Systems Department  
**Address:** French Rd.  
Utica, NY 13503  
**Contact:** Alexander Horvath  
**Position:** General Manager  
**Notes:** Research into pattern recognition.

**Organization:** General Microwave Corp.  
**Component:**  
**Address:** 5500 New Horizon Blvd  
Amityville, NY, 11701  
**Contact:** Sherman Rinkel  
**Position:** Pres  
**Notes:** Applied sensor technology for industrial and automotive applications.

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**Organization:** General Motors Corporation  
**Component:** Hughes Aircraft Co., Research Laboratories  
**Address:** 3011 Malibu Canyon Rd  
Malibu, CA 90265  
**Contact:** Arthur Chester  
**Position:** VP  
**Notes:** Production of GaAs and InP integrated circuits; infrared sensors, especially monolithic focal plane arrays.

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**Organization:** General Motors, Corporation  
**Component:** Santa Barbara Research Center  
**Address:** 75 Coromar Dr.  
Goleta, CA 93117  
**Contact:** Fletcher Phillips  
**Position:** President  
**Notes:** Manufacture of infrared photodetectors and associated components, packages and infrared focal plane arrays; electro-optical instrumentation for space; particularly multispectral earth observation sensors and weather sensors; specialized military equipment such as vehicle fire sensors and missile proximity fuses.

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**Organization:** Geonex Verde Technologies  
**Component:**  
**Address:** 734 E. Lake Avenue  
Watsonville, CA 95076  
**Contact:** Paul Reising  
**Position:** Mr.  
**Notes:** active in infrared remote sensing

**Organization:** Georgia Institute of Technology  
**Component:**  
**Address:**  
**Contact:** C.J. Summers  
**Position:**  
**Notes:** On Program Committee of 1991 & 1992 MCT Workshop  
For 1991 Workshop, "Selected-area Epitaxy on CdTe," and "Gas Source Iodine Doping and Characterization of MBE Grown CdTe"

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**Organization:** Georgia Tech Research Institute  
**Component:** Physical Sciences Laboratory  
**Address:** Room 128 Baker Bldg  
Atlanta, GA 30332  
**Contact:** R.G. Benz  
**Position:**  
**Notes:** Authored "CdTe and HgTe Growth Kinetics During Gas Source Molecular Beam Epitaxy" for 1992 MCT Workshop  
For 1991, "Selected-area Epitaxy of CdTe"

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**Organization:** GFI Advanced Technologies, Inc.  
**Component:**  
**Address:** 112-41 69th Avenue  
Forest Hills, NY 113754  
**Contact:** Karl Lifschitz  
**Position:** Chief Executive  
**Notes:** Manufacture of GaAs, germanium, ZnS, and ZnSe for infrared applications.

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**Organization:** Glenro, Inc.  
**Component:**  
**Address:** 29 McBride Ave.  
Paterson, NJ 07501  
**Contact:** Hervert Van Denend  
**Position:** Pres  
**Notes:** Research into infrared system production.

**Organization:** Graduate Center for the City Univ of NY  
**Component:** Dept of Electrical Engineering and Physics  
**Address:** Institute for Ultrafast Spectroscopy & Lasers, Photonics Appl Lab  
New York, NY 10031  
**Contact:** K.M. Yoo  
**Position:** Dr.  
**Notes:** active in infrared biomedical thermography

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**Organization:** Groton Technology, Inc.  
**Component:**  
**Address:** 45 Winthrop St.  
Concord, MA 01742  
**Contact:** George Barringer  
**Position:** Pres  
**Notes:** Applied and product-oriented research in optical interferometry and solid state optical detectors. Application of infrared technologies to scientific spectroscopy.

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**Organization:** Grumman Aircraft Systems  
**Component:**  
**Address:** MS B46-35  
Bethpage, NY 11714  
**Contact:** Michel Engelhardt  
**Position:**  
**Notes:** active in infrared process control

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**Organization:** Grumman Corporate Research Center  
**Component:**  
**Address:** Bethpage, NY 11714-3580  
**Contact:** M.B. Lee  
**Position:** Mr.  
**Notes:** Co-authored for 1992 MCT workshop "White Beam X-ray Synchrotron Topography Analysis of CdTe (111)B Substrates and Epilayers"

**Organization:** Hardin Optical Company  
**Component:**  
**Address:** P.O. Box 219  
1320 Oregon Avenue  
Bandon, OR 97411  
**Contact:** Larry Hardin  
**Position:** President  
**Notes:** Manufacture of GaAs, germanium, silicon, ZnS, and ZnSe for infrared applications.

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**Organization:** Harris Corporation  
**Component:** Government Communications Systems Division  
**Address:** 256 SE Palm Bay Rd., PO Box 9100  
Melbourne, FL 32902  
**Contact:** alan Henry  
**Position:** Gmgr  
**Notes:** Satellite and terrestrial communications, electro-optics, imagery and voice privacy systems.

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**Organization:** Harris RF Communications  
**Component:**  
**Address:** 1680 University Avenue  
Rochester, NY 14610  
**Contact:** John Cicotta  
**Position:** Marketing Communications Manager  
**Notes:** Thermal imaging, digital imaging systems, imaging software

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**Organization:** Harvard University  
**Component:** Division of Applied Sciences  
**Address:** Cambridge, MA 92138  
**Contact:** H. Ehrenreich  
**Position:**  
**Notes:** Co-Authored "Augur Lifetimes in Ideal InGaSb/InAs Superlattices" for 1992 MCT Workshop.

**Organization:** Helix Technology Corp  
**Component:** CTI Cryogenics Div  
**Address:** Nine Hampshire Street  
Mansfield, MA 02048

**Contact:**  
**Position:**  
**Notes:** cryogenic equipment

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**Organization:** HGH Ingenerie Systemes  
**Component:**  
**Address:** au Parc d'Activities du Moulin de Massy  
3, rue du Saule Trapu  
Massy, 91300 FRANCE  
**Contact:** Michel Balle

**Position:**  
**Notes:** active in infrared process control

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**Organization:** Honeyhill Technical Corporation

**Component:**  
**Address:** 193 East Avenue  
Norwalk, CT 06855

**Contact:** Herbert Kaplan  
**Position:** President

**Notes:** Contributing editor to Photonics Spectra, consultant in IR business. Someone good for exposure of IDT study

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**Organization:** Honeywell Corp.  
**Component:** Sensor and System Development Center  
**Address:** Bloomington, MN 55420

**Contact:** B.R. Johnson  
**Position:** Mr.

**Notes:** Co-authored for 1992 SPIE Workshop on IRFPAs "YBa<sub>2</sub>Cu<sub>3</sub>O<sub>7</sub> Superconducting Microbolometer Linear Arrays" supported by DARPA with Office of Naval Research as contracting agency.

**Organization:** Honeywell, Inc.  
**Component:** Solid State Sensors Group  
**Address:** 830 E. Arapaho Road  
Richardson, TX 75081  
**Contact:** J. Buie  
**Position:** Marketing Manager  
**Notes:** Manufactures IR optoelectronic components and assemblies, fiberoptic components, and modules.

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**Organization:** Huazhong University of Science and Technology  
**Component:**  
**Address:** Wuhan, Hubei 430074  
REPUBLIC OF CHINA  
**Contact:** Wang Lingjie  
**Position:**  
**Notes:** Authored for 1992 SPIE IRFPA meeting "Optimum Design Model for the Injection of IRCCD"

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**Organization:** Hughes Aircraft Co.  
**Component:** Electron Dynamics Division  
**Address:** 3100 W. Lomita  
Torrance, CA 90509-2999  
**Contact:** J.A. Christensen  
**Position:** Marketing Director  
**Notes:**

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**Organization:** Hughes Aircraft Company  
**Component:**  
**Address:** 328 Ellen Street  
Midland, Ontario, L4R 2H2, CANADA  
**Contact:** J. Mactaggart  
**Position:** VP Marketing  
**Notes:**



**Organization:** ICI America  
**Component:**  
**Address:** Wilmington, DE  
**Contact:**  
**Position:**  
**Notes:** A variety of work with InP, primarily for solar applications.

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**Organization:** II-VI Inc.  
**Component:**  
**Address:** 375 Saxonburg Blvd  
Saxonburg, PA 16056  
**Contact:** Carl Johnson  
**Position:** President and CEO  
**Notes:** Manufacture of CdTe, GaAs, germanium, silicon, ZnS, ZnSe for infrared applications.

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**Organization:** Imago Machine Vision Inc.  
**Component:**  
**Address:** 1354 Wellington Street  
Ottawa, Ontario, CANADA K1Y 3C3  
**Contact:** Roy Ball  
**Position:** President  
**Notes:** Security systems and equipment, robotics, c/o systems, infrared systems and equipment

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**Organization:** Imagraph Corp.  
**Component:**  
**Address:** 11 Elizabeth Drive  
Chelmsford, MA 01824  
**Contact:** Joseph Plonski  
**Position:** V.P. Sales and Marketing  
**Notes:** thermal imaging

**Organization:** IMEC  
**Component:**  
**Address:** Jaoekdreef 75  
B-3001 Leuven, BELGIUM  
**Contact:** Jan Vermeiren  
**Position:** Ms.  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Comparative study of SWIR and MWIR Schottky-Barrier Imagers"

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**Organization:** Imo  
**Component:** Varian Industries  
**Address:** Palo Alto, CA  
**Contact:** Alan Bennett  
**Position:** V Pres R&D  
**Notes:** Producer of a wide variety of military thermal systems. Development of InP- and HgCdTe-based infrared sensors, as well as the use of GaAs materials.

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**Organization:** Indiana State University  
**Component:** Department of Geography and Geology  
**Address:** Terre Haute, IN 47809  
**Contact:** David J. Kettler  
**Position:** Mr.  
**Notes:** active in infrared remote sensing

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**Organization:** Inframetrics  
**Component:**  
**Address:** 16 Esquire Road  
North Billerica, MA 01862  
**Contact:** Charles Alicandro  
**Position:** Commercial Sales  
**Notes:**

**Organization:** Infrared Engineering Services  
**Component:**  
**Address:** 110 Shadow Oaks Drive  
Easley, SC 29642  
**Contact:** William T. Morgan  
**Position:** Mr.  
**Notes:** infrared non-destructive evaluation

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**Organization:** Infrared Industries  
**Component:**  
**Address:** 12151 Research Pkwy, Orlando, FL 32826  
**Contact:** Ed Patton  
**Position:** COO  
**Notes:** Lead sulphide, lead selenide, indium antimonide and silicon infrared detectors and thin film optical filters for government and industrial applications; hybrid preamplifier microcircuits.

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**Organization:** Infrared Monitoring Systems  
**Component:**  
**Address:** 10 West 35th Street  
Chicago, IL 60616  
**Contact:** Ed Bangs  
**Position:**  
**Notes:** active in infrared process control

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**Organization:** Infrared Optical Products, Inc.  
**Component:**  
**Address:** P.O. Box 3033  
South Farmingdale, NY 11735  
**Contact:** Barry Bassin  
**Position:** President  
**Notes:** Manufacture of CdTe, GaAs, germanium, silicon, ZnS, and ZnSe for infrared applications.

**Organization:** Infrared Research, Inc.  
**Component:**  
**Address:** 100 Park City Road  
Roosville, GA 30741  
**Contact:** James Garner  
**Position:** Mr.  
**Notes:** active in infrared predictive maintenance

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**Organization:** Infrared Scanning, Inc.  
**Component:**  
**Address:** 3955 Pleasantdale Rd.  
Atlanta, GA 30340  
**Contact:** Robert Lacer  
**Position:** Pres  
**Notes:** Infrared inspection techniques and applications.

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**Organization:** Infraspction Institute  
**Component:**  
**Address:** 1971 Shelburne Road, Suite C  
Shelburne, VT 05482  
**Contact:** Paul Grover  
**Position:** Mr.  
**Notes:** active in infrared predictive maintenance

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**Organization:** Innovation Industries, Inc.  
**Component:**  
**Address:** Hwy 64E PO Box K  
Russellville, AR 72801  
**Contact:** Tom Benson  
**Position:** CEO  
**Notes:** Opto-electronics product oriented for patent and manufacture.

**Organization:** Institute for Atomic Physics  
**Component:**  
**Address:** ROMANIA  
**Contact:** D.N. Lazarovici  
**Position:**  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Accurate Method for Neutron Fluence Control Used in Improving Neutron-Transmutation-Doped Silicon Detectors"

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**Organization:** Intergraph Corp.  
**Component:**  
**Address:** 2051 Mercator Drive  
Reston, VA 22091  
**Contact:** John Dahmes  
**Position:** Executive Manager, Marketing  
**Notes:** Thermal Imaging, imaging software

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**Organization:** International Advanced Materials Inc.  
**Component:**  
**Address:** 2 North Circle Avenue  
Spring Valley, NY 10977  
**Contact:** JoElaine Cary  
**Position:** CEO  
**Notes:** Manufacture of CdTe, GaAs, germanium, silicon, ZnS, and ZnSe materials for infrared systems.

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**Organization:** International Crystal Laboratories  
**Component:**  
**Address:** 11 Eric St.  
Garfield, NJ 07026  
**Contact:** Theresa Herpst  
**Position:** Pres  
**Notes:** Applied research for growing crystals for infrared transmission.

**Organization:** International Imaging Systems  
**Component:**  
**Address:** 1500 Buckeye Drive  
Milpitas, CA 95035  
**Contact:**  
**Position:**  
**Notes:** remote sensing systems, thermal infrared, multispectral

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**Organization:** International Machine & Tool Corp.  
**Component:** Instrument & Development Laboratory  
**Address:** 115 Maple St.  
Warwick, RI 02888  
**Contact:** WJ Elsdoefer  
**Position:** Pres  
**Notes:** Electronic and optical measurement development.

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**Organization:** International Optical Telecommunications  
**Component:**  
**Address:** 18 E Blithedale Ave.  
Mill Valley, CA 94941-1916  
**Contact:** Dr. Herbert Elion  
**Position:** CEO  
**Notes:** Hardware and software market research including lab facilities, design improvement and patenting technology assistance.

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**Organization:** International Research and Evaluation  
**Component:**  
**Address:** 21098 IRE Control Ctr.  
Eagan, MN 55121  
**Contact:** Randall Voight  
**Position:** CEO  
**Notes:** Product-oriented with emphasis on photovoltaic cells.

**Organization:** International Sensor Systems, Inc.  
**Component:**  
**Address:** Industrial Park, PO Box 345  
Aurora, NE 68818  
**Contact:** Clifford Williams  
**Position:** Pres  
**Notes:** Research in hybrid thick film technology and optical relays.

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**Organization:** International Solar Electric Technologies  
**Component:**  
**Address:** Englewood, CA  
**Contact:**  
**Position:**  
**Notes:** Development research on a variety of infrared materials, including CIS, for solar applications.

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**Organization:** Interscan Corporation  
**Component:**  
**Address:** 21700 Nordhoff St. PO Box 2496  
Chatworth, CA 91313-2496  
**Contact:** Dr Manny Shaw  
**Position:** Pres  
**Notes:** Gas analyzer and sensor developments.

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**Organization:** IR Scientific Inc  
**Component:**  
**Address:** PO Box 110  
Carlisle, MA 01741  
**Contact:** R Sommer  
**Position:** Pres  
**Notes:** Product-oriented near infrared research and development manufacturing and infrared consulting services.

**Organization:** Iri Vision  
**Component:**  
**Address:** Suite D, 6231 Yarrow Dr.  
Carlsbad, CA 92009  
**Contact:** Lawrence Goshorn  
**Position:** CEO  
**Notes:** Product-oriented research of light-based vision systems.

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**Organization:** Irtronics Instruments, Inc.  
**Component:**  
**Address:** 132 Forest Blvd.  
Ardsley, NY 10502  
**Contact:** John Jenkofsky  
**Position:** Gmgr  
**Notes:** Standard and custom infrared radiation pyrometers for measuring temperature in industrial research applications.

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**Organization:** Irvine Sensors Corp.  
**Component:**  
**Address:** 3001 Redhill Ave Bldg 3  
Costa Mesa, CA 92626  
**Contact:** James Alexiou  
**Position:** Pres  
**Notes:** Applied research in military detection system (infrared sensing).

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**Organization:** Iscan, Inc.  
**Component:**  
**Address:** 125 Cambridgepark Drive  
Cambridge, MA 02140  
**Contact:** Rikki Razdan  
**Position:** Marketing Manager  
**Notes:** Infrared systems and equipment, c/o systems



**Organization:** ISI Group  
**Component:**  
**Address:** 211 Conchas SE  
Albuquerque, NM 87123  
**Contact:** James Fritz  
**Position:** Mr.  
**Notes:** active in infrared process control

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**Organization:** ISPRA - Israel Product Research Co. Ltd.  
**Component:**  
**Address:** Galgal Haplada Street, Industrial Zone  
Herzeliya, Israel 052-555464  
**Contact:**  
**Position:**  
**Notes:** Manufacture of germanium, silicon, ZnS, and ZnSe for infrared applications.

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**Organization:** Israel Aircraft Industries, Ltd.  
**Component:**  
**Address:** Ben-Gurion International Airport  
Israel 70100  
**Contact:** F.P. Hermann  
**Position:** Corp. Foreign Press and Adv. Mgr.  
**Notes:** passive and active e/o components, detectors and sensors, infrared systems and equipment

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**Organization:** ITD - Space Remote Sensing Center  
**Component:**  
**Address:** Building 1103 Suite #118  
Stennis Space Center, Mississippi 39529  
**Contact:** George A. May  
**Position:** Mr.  
**Notes:** active in infrared remote sensing

**Organization:** ITI Electro-Optics Corp.  
**Component:**  
**Address:** 11500 W Olympic Blvd  
Los Angeles, CA 90064  
**Contact:** Richard Caserio  
**Position:** Sales Manager  
**Notes:** Manufacture of CdTe, GaAs, germanium, ZnS, and ZnSe for infrared technologies.

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**Organization:** ITT Defense and Electronics  
**Component:**  
**Address:** 1000 Wilson Boulevard, Suite 3000  
Arlington, VA 22209  
**Contact:** Brandon Belote  
**Position:** Director Marketing Communications  
**Notes:** Night vision, active and passive e/o systems, infrared systems and components

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**Organization:** JA Noll Co.,  
**Component:**  
**Address:** PO Box 312  
Monroeville, PA 15146  
**Contact:** JA Noll  
**Position:** CEO  
**Notes:** Research in optical metrology.

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**Organization:** Jamieson Science and Engineering  
**Component:**  
**Address:**  
**Contact:** James Jamieson  
**Position:** President  
**Notes:** Advocate of MCT being able to overcome cost barriers to break into commercial market. Long history of involvement in IR since advent.

**Organization:** Janos Technology, Inc.  
**Component:**  
**Address:** HCR #33, Box 25  
Townshend, VT 05353-7702  
**Contact:** Bruce Gardner  
**Position:** Pres  
**Notes:** Manufacturer of CdTe, GaAs, germanium, silicon, ZnS, and ZnSe for infrared applications.

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**Organization:** Jodon Engineering  
**Component:**  
**Address:** 62 Enterprise Dr.  
Ann Arbor, MI 48103  
**Contact:** John Gillespi  
**Position:** Pres  
**Notes:** Optical engineering for machine vision.

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**Organization:** John Snell & Associates  
**Component:**  
**Address:** 17 First Avenue  
Montpelier, VT 05602  
**Contact:** Robert W. Spring  
**Position:** Mr.  
**Notes:** active in infrared predictive maintenance

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**Organization:** Johns Hopkins University  
**Component:** Center for NDE and Applied Physics Laboratory  
**Address:** Laurel, MD 20723  
**Contact:** James C. Murphy  
**Position:** Mr.  
**Notes:** infrared non-destructive evaluation

**Organization:** JTT International Inc.  
**Component:**  
**Address:** 3045 Technology Pkwy  
Orlando, FL 32826  
**Contact:** Dr. M.Y. Hwang  
**Position:** Ch. Sci  
**Notes:** Manufacturer of germanium, silicon, ZnS, and ZnSe infrared systems.

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**Organization:** Kappler Crystal Optics Inc.  
**Component:**  
**Address:** 1244 Highland Street  
Holliston, MA 01746  
**Contact:** Ronald Kappler  
**Position:** Pres.  
**Notes:** Manufacturer of ZnS and ZnSe for infrared applications.

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**Organization:** Kemet Electronics Corporation  
**Component:**  
**Address:** 2605 Laurens Hwy., PO Box 5928, Greenville, SC 29606  
**Contact:** DE Maguire  
**Position:** Pres  
**Notes:** Applied research and development on passive electronic components.

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**Organization:** Kidron Microelectronics Research Center  
**Component:** Department of Electrical Engineering  
**Address:** Technion-Israel Institute of Technology  
Haifa 32000, ISRAEL  
**Contact:** A. Bezinger  
**Position:**  
**Notes:** "UV Photon Assisted Control of Interface Charge Between CdTe Substrates and Metal Organic Chemical Vapor Deposition CdTe Epilayers" for 1992 MCT Workshop.

**Organization:** King's College  
**Component:** Thermal Biology Research Unit  
**Address:** Campden Hill Road, Kensington  
London, W8 7AH, UNITED KINGDOM  
**Contact:** Ray P. Clark  
**Position:** Dr.  
**Notes:** active in infrared biomedical thermography

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**Organization:** King's College London, University of London  
**Component:** Thermal Biology Research Unit  
**Address:** Campden Hill Road  
Kensington, Longon W8 7AH UNITED KINGDOM  
**Contact:** Ray P. Clark  
**Position:** Dr.  
**Notes:** President of European Academy of Thermology. Interviewed 1-16

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**Organization:** Kistler-Morse Corporation  
**Component:**  
**Address:** 10201 Willows Rd., NE, PO Box 3009, Redmond, WA 98073  
**Contact:** Charlie Morse  
**Position:** Pres  
**Notes:** R&D of semiconductor displacement sensors.

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**Organization:** Kollmorgen Corp.  
**Component:**  
**Address:** 347 King Street  
Northampton, MA 01060  
**Contact:** Doug James  
**Position:** Systems Engineer  
**Notes:** Detectors and sensors, infrared systems and equipment, night vision

**Organization:** Kollmorgen Corporation  
**Component:** Photo Research  
**Address:** 9330 DeSoto Dr.  
Chatsworth, CA 91311  
**Contact:** James Fogle  
**Position:** VP  
**Notes:** Optical and electromechanical light measuring devices.

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**Organization:** Kollsman Division of Sequa Corp.  
**Component:**  
**Address:** 220 Daniel Webster Highway  
Merrimack, NH 03054  
**Contact:** Jeannette Neff  
**Position:** Mgr. Marketing Communications  
**Notes:** E/O Systems, infrared systems and equipment, night vision

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**Organization:** Korca University  
**Component:**  
**Address:** Chong Am Dong  
Sung-Buk-Ku  
Seoul, KOREA 11136-701  
**Contact:** Sun Ung Kim  
**Position:**  
**Notes:** Attended 1992 MCT Workshop

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**Organization:** KRS Electronics Corporation  
**Component:**  
**Address:** Suite 16, 11649 Chairman Dr.  
Dallas TX, 75243  
**Contact:** Steve Zimmerman  
**Position:** Pres  
**Notes:** Optical electronic sensing of liquids gases and temperatures.

**Organization:** Kussmaul Electronics Company, Inc.  
**Component:**  
**Address:** 170 Cherry Ave.  
West Sayville, NY 11796  
**Contact:** Ernest Kussmaul  
**Position:** Pres  
**Notes:** R&D of photoelectronic controls.

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**Organization:** Lab de Physique des Solides/ INSA  
**Component:**  
**Address:**  
**Contact:** R. Granger  
**Position:** Mr.  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Infrared Reflectivity: A tool for bond Investigation in II-VI Ternaries"

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**Organization:** LaBarge Inc.  
**Component:** LaBarge Electronics  
**Address:** 11616 E 51st St.  
Tulsa, OK 74146  
**Contact:** Bob Stauder  
**Position:** VP  
**Notes:** Intrusion detection systems and components, telemetry systems and components and other eletromechanical systems and components for airborne and space applications; atmospheric, weather and data measuring systems and components.

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**Organization:** Laboratory for Infrared Physics  
**Component:** Academia Sinica  
**Address:** 420 Zhong Shan Bei Yi Road  
Shanghai, 200083, CHINA  
**Contact:** Qian Dingrong  
**Position:**  
**Notes:** Authored for 1992 SPIE meeting on IRFPAs "Element of a new Infrared Detector Plasma Edge Detector"

**Organization:** Laser Diode Inc.  
**Component:**  
**Address:** 205 Forrest Street  
Metuchen, NJ 08840-1292  
**Contact:** Bob Gill  
**Position:** President  
**Notes:** Manufacturer of GaAs and germanium materials for infrared applications.

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**Organization:** Laser Fare, Inc.  
**Component:**  
**Address:** One Industrial Dr S  
Esmond, RI 02917  
**Contact:** Terry Feeley  
**Position:** Pres  
**Notes:** Applied laser technology to industrial materials processing; research in aerospace, medical and electronic applications.

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**Organization:** Laser Focus World  
**Component:**  
**Address:** One Technology Park Drive  
P.O. Box 989  
Westford, MA 01886  
**Contact:** David Kales  
**Position:** Senior Editor, Markets  
**Notes:** Wrote November 1992 article "Detector Makers Seek Dual-Use Technology for Survival." Friends with David Leech.

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**Organization:** Laser SOS Limited  
**Component:**  
**Address:** 4B Bartholomew's Walk  
Cambridgeshire Bus. Pk., Angel Drove  
Ely, Camb. CB74EAG  
**Contact:** A.W. Koszykowski  
**Position:** Pres.  
**Notes:** Manufacture of CdTe, GaAs, germanium, silicon, ZnS, and ZnSe for infrared applications.



**Organization:** Lasermike, Inc.  
**Component:**  
**Address:** 6060 Executive Blvd  
Dayton, OH 45424  
**Contact:** Steve Cox  
**Position:** Pres  
**Notes:** Development of intelligence sensors.

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**Organization:** Lattice Materials Corp.  
**Component:**  
**Address:** 516 E. Tamrack  
Bozeman, MT 59715  
**Contact:** John Tengelsen  
**Position:** Pres.  
**Notes:** Manufacturer of silicon for infrared applications.

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**Organization:** Lawrence Livermore National Laboratories  
**Component:**  
**Address:** Livermore, CA 94551  
**Contact:** Nancy C. DelGrande  
**Position:** Ms.  
**Notes:** active in infrared remote sensing

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**Organization:** LETI (CEA - Technologies Avancees)  
**Component:** DOPT - CEN/G - 85 X  
**Address:** F38041 Grenoble Cedex FRANCE  
**Contact:** G. Destefanis  
**Position:** Mr.  
**Notes:** Co-authored for 1992 MCT Workshop "Large Improvement in HgCdTe Photovoltaic Detector Performances at LETI"

**Organization:** Life Support, Inc.  
**Component:**  
**Address:** 2926 State St.  
Erie, PA 16509  
**Contact:** Dr Eskil Karlson  
**Position:** Dir  
**Notes:** Optical system design including IR detection and systems.

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**Organization:** Liquid Carbonic  
**Component:**  
**Address:** 135 LaSalle  
Chicago, IL 60603  
**Contact:**  
**Position:**  
**Notes:** cryogenic equipment

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**Organization:** Litton Corporation  
**Component:**  
**Address:** 1725 Jefferson Davis Highway  
Suite 601, Crystal Square Two  
Arlington, VA 22203  
**Contact:** John Georg  
**Position:** Public Relations Manager  
**Notes:** e/o systems, night vision, infrared systems and equipment, detectors & sensors

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**Organization:** Litton Electron Devices  
**Component:**  
**Address:** 1215 S. 52nd Street  
Tempe, AZ 85281  
**Contact:** Paul Everett  
**Position:** Manager, Business Development  
**Notes:**

**Organization:** Litton Electron Devices Product Group  
**Component:**  
**Address:** 1215 South 52nd Street  
Tempe, AZ 85281  
**Contact:**  
**Position:**  
**Notes:**

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**Organization:** Litton Industries, Inc.  
**Component:** Applied Technology Division  
**Address:** 4747 Hellyer Ave., PO Box 7012  
San Jose, CA 95150-7012  
**Contact:** Clayton Williams  
**Position:** Pres  
**Notes:** Electro-optic and acouto-optic systems.

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**Organization:** Lockheed Corporation  
**Component:** Lockheed Palo Alto Research Laboratories  
**Address:** 3251 Hanover St., Orgn 90-01  
Palo Alto, CA 94304  
**Contact:** JB Reagan  
**Position:** General Manager  
**Notes:** Research and development of electro-optic systems, including HgCdTe under DARPA's Electronic Sciences program.

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**Organization:** Lockheed Missiles & Space Co., Inc.  
**Component:**  
**Address:** 1111 Lockheed Way  
Sunnyvale, CA 94088  
**Contact:** Larry M. Klynn  
**Position:** Mr.  
**Notes:** infrared non-destructive evaluation

**Organization:** Lockheed Sanders, Inc.  
**Component:**  
**Address:** NHQ-1-735  
68 Spit Brook Road  
Nashua, NH 03061  
**Contact:** Marvin L. Braman  
**Position:** Director of Public Relations  
**Notes:** Infrared systems and equipment, passive and active c/o devices

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**Organization:** Loral Corporation  
**Component:** Loral Fairchild Systems  
**Address:** 300 Robbins Ln.  
Syosset, NY 11791  
**Contact:** James Dunn  
**Position:** Pres  
**Notes:** Development of electro-optical imaging systems.

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**Organization:** Loral Corporation  
**Component:** Loral Infrared & Imaging Systems, Inc.  
**Address:** 2 Forbes Rd.  
Lexington, MA 02173  
**Contact:** R.A. Bell  
**Position:** Director of Marketing  
**Notes:**

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**Organization:** Loral Electro-Optical Systems  
**Component:**  
**Address:** 300 North Halstead Street  
Pasadena, CA 91107  
**Contact:** Jim Carey  
**Position:** Marketing Director  
**Notes:** Infrared systems and equipment, c/o systems

**Organization:** Lousiana Tech University  
**Component:**  
**Address:**  
**Contact:** David H. Cowling  
**Position:**  
**Notes:** Co-authored 1990 "A Simplified Vision System With Robotic Assembly and Manufacturing Applications"

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**Organization:** LTV Aerospace and Defense Company  
**Component:**  
**Address:** Mail Stop PT-88  
Dallas, TX 75265  
**Contact:** Y.L. Tyan  
**Position:** Mr.  
**Notes:** Co-authored for 1991 MCT Workshop "Analysis of Excess Carrier Lifetime in p-Type HgCdTe Using a Three-Level Shockley-Read Model"

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**Organization:** Luoyang Optic-Electronic Institute  
**Component:**  
**Address:** P.O. Box 030-12, 471009, Luoyang, Henan, P.R. CHINA  
**Contact:** Yongping Ni  
**Position:**  
**Notes:** Authored for 1992 SPIE meeting on IRFPAs "Auto-Gain-Control Characteristics of InSb P+/N Diode with High Sheet Resistance"

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**Organization:** MacDonald, Dettwiler & Associates, Ltd  
**Component:**  
**Address:** 13800 Commerce Parkway  
Richmond, BC, V6V 2J3  
CANADA  
**Contact:**  
**Position:**  
**Notes:** remote sensing systems, thermal infrared

**Organization:** MacVicar Associates  
**Component:**  
**Address:** 1171 Buckingham Drive  
Los Altos, VA 94024  
**Contact:** Duncan MacVicar  
**Position:** Consultant, President  
**Notes:** Consultant on electro-optics

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**Organization:** Magna Industries, Inc  
**Component:**  
**Address:** 2201 W 110th St., PO Box 734  
Cleveland, OH 44107  
**Contact:** Larry Whited  
**Position:** Pres  
**Notes:** Research in infrared products.

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**Organization:** Magnavox Corporation  
**Component:**  
**Address:** 1313 Production Road  
Fort Wayne, IN 46808  
**Contact:**  
**Position:**  
**Notes:** Participant in Army's night vision investigation program to develop advanced thermal night vision systems.

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**Organization:** Magnavox Electronic Systems Company  
**Component:** Electro-Optical Systems  
**Address:** 46 Industrial Avenue  
Mahwah, NJ 07430-2206  
**Contact:** Dan Laerfeld  
**Position:** Marketing Manager  
**Notes:**

**Organization:** Marconi Radar and Control Systems, Ltd.  
**Component:**  
**Address:** P.O. Box 133  
Chobham Road, Frimley  
Camberley, Surrey, UK GU16 5PE  
**Contact:** Mark Broughton  
**Position:** Head of public Relations  
**Notes:** Thermal Imaging, detectors and sensors, night vision

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**Organization:** Marine-Air Systems  
**Component:**  
**Address:** 24 Bridge Street  
P.O. Box 30-248  
Lower Hutt, NEW ZEALAND  
**Contact:** David Clist  
**Position:** Business Development Manager  
**Notes:** c/o systems, detectors & sensors, infrared systems & equipment, thermal imaging

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**Organization:** Marlow Industries, Inc.  
**Component:**  
**Address:** 10451 Vista Park Road  
Dallas, TX 75238-1645  
**Contact:** Bill Kolander  
**Position:** Product Marketing Manager  
**Notes:** infrared systems & equipment, night vision, detectors and sensors, c/o systems

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**Organization:** Martin Marietta  
**Component:**  
**Address:** 103 Chesapeake Park Plaza  
Mail point 110  
Baltimore, MD 21220  
**Contact:** William Greenlaw  
**Position:** Mr.  
**Notes:**

**Organization:** Matrix Scientific Systems  
**Component:**  
**Address:**  
**Contact:** Ken Matz  
**Position:** Mr.  
**Notes:**

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**Organization:** Maury Microwave Corp  
**Component:**  
**Address:** 2900 Inland Empire Blv  
Ontario, CA 91764

**Contact:**  
**Position:**  
**Notes:** cyrogenic equipment

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**Organization:** McCallum & Associates, Inc.  
**Component:**  
**Address:** 330 Pearl Street, Suite 3A  
New York, NY 10038

**Contact:** Alex McCallam  
**Position:** President  
**Notes:** Represents MediScience, Inc, which funded Alfano's work at CCNY on breast cancer detection. Interests in additional funding. Sees use in cancer pre-diagnosis and cardiology during operations.

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**Organization:** McDonnell Douglas Tech Inc.  
**Component:**  
**Address:** 11955 Bajada Road  
San Diego, CA 92128-2023  
**Contact:** Bob Madding  
**Position:** Mr.  
**Notes:** active in infrared remote sensing



**Organization:** McDonnell Douglas Aerospace  
**Component:**  
**Address:** 1801 E. St. Andrew Place  
Santa Ana, CA 92705  
**Contact:** Nick Willick  
**Position:** Senior Manager  
**Notes:** Night Vision, thermal imaging, e/o systems

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**Organization:** McDonnell Douglas Corporation  
**Component:** MD Research Laboratories  
**Address:** PO Box 516  
Saint Louis, MO 63166  
**Contact:** John Dimmock  
**Position:** Gmgr  
**Notes:** Infrared detectors and fluid dynamics.

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**Organization:** McGill University  
**Component:**  
**Address:**  
**Contact:** L. Kops  
**Position:**  
**Notes:** Co-authored 1983 "Application of Infrared Radiation Measurements in Grinding Studies"

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**Organization:** MCP Wafer Technology  
**Component:**  
**Address:** Unit 34, Maryland Road, Tongwell, Milton Keynes, Bucks, MK158HJ  
UNITED KINGDOM  
**Contact:** K.C. Lamb  
**Position:** Marketing Manager  
**Notes:** Production of CdTe and GaAs for infrared applications.

**Organization:** MDA Scientific, Inc.  
**Component:**  
**Address:** Suite 185, 3000 Northwoods Pkwy  
Norcross, GA 30071  
**Contact:** Orman Simpson  
**Position:** Pres  
**Notes:** Optical remote sensing techniques.

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**Organization:** Melles Griot  
**Component:**  
**Address:** 1770 Kettering St.  
Irvine, CA 92714  
**Contact:** Jan Melles  
**Position:** CEO  
**Notes:** Research into optical sciences and optical thin films.

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**Organization:** Merlin Engineering  
**Component:**  
**Address:** 1888 Embarcadero Road  
Palo Alto, CA 94303  
**Contact:** Dan Dusel  
**Position:** Vice President  
**Notes:** thermal imaging, infrared systems & equipment

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**Organization:** MET, Inc.  
**Component:**  
**Address:** Dallas, TX  
**Contact:**  
**Position:**  
**Notes:** A joint effort between Hughes and Texas Instruments to develop large scanning arrays for use on the RAH-66 helicopter.

**Organization:** Metaleurop  
**Component:**  
**Address:** Langelsheim, Germany  
**Contact:**  
**Position:**  
**Notes:** Manufacture of germanium for infrared applications.

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**Organization:** Microwave Technology Incorporated  
**Component:**  
**Address:** 4268 Solar Way  
Fremont, CA 94538  
**Contact:** Bill Wilson  
**Position:** Pres  
**Notes:** Research on GaAs and silicon for infrared applications.

---

**Organization:** Mikron Instruments  
**Component:**  
**Address:** 445 W. Main Street  
Wyckoff, NJ 07481  
**Contact:** K. Irani  
**Position:**  
**Notes:** infrared non-destructive evaluation

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**Organization:** Minco Prods Inc  
**Component:**  
**Address:** 7300 Commerce Lane  
Minneapolis, MN 55432  
**Contact:**  
**Position:**  
**Notes:** cryogenic equipment

**Organization:** Minnesota University  
**Component:** Department of Electrical Engineering  
**Address:** Minneapolis, MN  
**Contact:** P.H. Handel  
**Position:**  
**Notes:** Co-authored August 1991 "Quantum Noise in Solid-State Devices in Particular HgCdTe Diodes"

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**Organization:** Mission Research Corporation  
**Component:**  
**Address:** Newington, VA 22122  
**Contact:** James P. Karins  
**Position:** Mr.  
**Notes:** Authored for 1992 SPIE workshop on IRFPAs "Models of Nonlinearities in Focal Plane Arrays"

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**Organization:** MIT  
**Component:**  
**Address:** Cambridge, MA 02139  
**Contact:** R.L. Aggarwal  
**Position:**  
**Notes:** On Program Committee of 1991 & 1992 MCT Workshop

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**Organization:** Mitsubishi Electric Corporation  
**Component:** LSI Laboratory  
**Address:** 4-1, Mizujara  
Itami, Hyogo, 664 JAPAN  
**Contact:** Hirofumi Yagi  
**Position:** Mr.  
**Notes:** Co-authored for 1992 SPIE Workshop on IRFPAs "Improved 512X512 IRCSD with Large Fill Factor and High Saturation Level"

**Organization:** Mitsubishi Electronics America, Inc.  
**Component:**  
**Address:** 5665 Plaza Drive  
Cypress, CA 90630  
**Contact:**  
**Position:**  
**Notes:**

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**Organization:** MMR Technology Inc  
**Component:**  
**Address:** 1400 North Shoreline Blvd, Ste A-5  
Mountain View, CA 94043-1312  
**Contact:**  
**Position:**  
**Notes:** cryogenic equipment

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**Organization:** Mobil Oil Corp.  
**Component:** Mobil Solar Energy Corp.  
**Address:** 4 Suburban Park Dr.  
Billerica, MA 01821  
**Contact:** BM Gillespi  
**Position:** Pres  
**Notes:** Solar cell and photovoltaic power components and systems development.

---

**Organization:** Monitek Technologies, Inc.  
**Component:**  
**Address:** 1495 Zephyr Ave.  
Hayward, CA 94544  
**Contact:** Kenneth Anderson  
**Position:** Pres  
**Notes:** Optical and electronic measurement systems to detect particulate matter, oils and color in fluids.

**Organization:** Morton International  
**Component:** CVD Incorporated  
**Address:** 185 New Boston St.  
Woburn, MA 01801  
**Contact:** Robert Donadio  
**Position:** Pres  
**Notes:** Material sciences, novel optical concepts and laser applications.

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**Organization:** MOSET Corporation  
**Component:**  
**Address:** El Toro, CA 92630  
**Contact:** Ken Zanio  
**Position:** Mr.  
**Notes:** Authored for 1992 SPIE Workshop on MCT "HgCdTe on Si for Monolithic Focal Plane Arrays" supported by NRL contract from Dean Scribner

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**Organization:** Motorola Corporation  
**Component:**  
**Address:** 1303 East Algonquin Road  
Schaumburg, IL 60196  
**Contact:** Ravi Bhatla  
**Position:**  
**Notes:** infrared non-destructive evaluation

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**Organization:** MR Semicon, Inc.  
**Component:**  
**Address:** 276 Route 59  
Tall Pines Industrial Park  
Monsey, NY 10952-3407  
**Contact:** Roger Waldock  
**Position:** Pres.  
**Notes:** Manufacture of CdTe and GaAs for infrared applications.

**Organization:** MS2i  
**Component:**  
**Address:** 38 Bd Paul Cezanne BP 235  
78052 St Quentin en Yvelines  
FRANCE  
**Contact:**  
**Position:**  
**Notes:** remote sensing systems, multispectral

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**Organization:** Mulloletto Optical Company, Inc  
**Component:**  
**Address:** 6100 Everall Ave.  
Baltimore, MD 21206  
**Contact:** Rose Jones  
**Position:** Pres  
**Notes:** Design and development of optical systems for underwater, laboratory and space applications.

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**Organization:** Nalorac Cryogenics Corp  
**Component:**  
**Address:** 837 Arnold Drive, Ste 600  
Martinez, CA 94553  
**Contact:**  
**Position:**  
**Notes:** cryogenic equipment

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**Organization:** NASA  
**Component:** Langley Research Center  
**Address:** MS 231  
Hampton, VA 23665  
**Contact:** Elliot Cramer  
**Position:** Mr.  
**Notes:** infrared non-destructive evaluation

**Organization:** NASA, Langley Research Center  
**Component:** Analytical Services and Manufacturing, Inc.  
**Address:** c/o MS 231  
Hampton, VA 23665  
**Contact:** Patricia A. Howell  
**Position:** Ms.  
**Notes:** infrared non-destructive evaluation

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**Organization:** National Institute of Standards and Technology  
**Component:** Semiconductor Electronics Division  
**Address:** Gaithersburg, MD 20899  
**Contact:** J.R. Lowney  
**Position:**  
**Notes:** Co-Authored "Heavily Accumulated Surfaces of MCT Detectors: Theory and Experiment" for 1992 MCT Workshop.  
For 1991 Workshop, "Investigation of Mercury Interstitials in MCT Alloys Using Resonant Impact-Ionization Spectroscopy"

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**Organization:** National Taiwan University  
**Component:** Department of Electrical Engineering  
**Address:** Taipei, Taiwan, REPUBLIC OF CHINA  
**Contact:** Shi-Chen Chao  
**Position:**  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Electrolyte Electroreflectance Spectroscopies for the Ion-Implanted HgCdTe with Thermal Annealing"

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**Organization:** NEC Corporation  
**Component:**  
**Address:** 4-1-1 Miyazaki  
Miyamae, Kawasaki, 216 JAPAN  
**Contact:** T. Sasaki  
**Position:** Mr.  
**Notes:** Co-authored for 1991 MCT Workshop "Study of CdTe Epitaxial Growth on (211)B GaAs by MBE"



**Organization:** NEC Corporation  
**Component:** Microelectronics Research Laboratories  
**Address:** 1120, Shimokuzawa, Kanagawa 229, JAPAN  
**Contact:** A. Tanabe  
**Position:** Mr.  
**Notes:** Co-authored for 1992 SPIE workshop on IRFPAs "Optimum Barrier Height in Schottky-Barrier Infrared CCD Image Sensor"

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**Organization:** NESLAB Instruments Inc  
**Component:**  
**Address:** PO Box 1178  
Portsmouth, NH 03802-1178  
**Contact:**  
**Position:**  
**Notes:** cryogenic equipment

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**Organization:** New Jersey Institute of Technology  
**Component:**  
**Address:** Newark, NJ 07102  
**Contact:** N.M. Ravindra  
**Position:**  
**Notes:** Authored for 1992 SPIE meeting on IRFPAs "HgCdTe Photovoltaic Detectors and Some Related Aspects"

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**Organization:** Newport Corporation  
**Component:**  
**Address:** 18235 Mount Baldy Circle  
Fountain Valley, CA 92708  
**Contact:** Dr Tom Galantowicz  
**Position:** CEO  
**Notes:** Electro-optic and electro-mechanical components and systems for laser optical applications.

**Organization:** Newport Industrial Glass Inc.  
**Component:**  
**Address:** 2044-C Placentia Avenue  
Costa Mesa, CA 92627  
**Contact:** Ray Larsen  
**Position:** Director  
**Notes:** Manufacturer of CdTe, GaAs, germanium, silicon, ZnS, and ZnSe for infrared applications.

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**Organization:** Nichols Research Corp.  
**Component:**  
**Address:** 4040 South Memorial Parkway  
Huntsville, AL 35802  
**Contact:** Patsy Hattox  
**Position:** Vice President  
**Notes:** Infrared systems and equipment, imaging software

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**Organization:** Nicolet Instrument Corporation  
**Component:** Spectra Tech Inc.  
**Address:** 652 Glenbrook Rd, PO Box 2190-G  
Stamford, CT 06906  
**Contact:** Donald Sting  
**Position:** CEO  
**Notes:** Infrared spectroscopy instruments and applications.

---

**Organization:** Night Vision Equipment Co., Inc.  
**Component:**  
**Address:** P.O. Box 266  
Emmaus, PA 18049  
**Contact:** Gene Adcock  
**Position:** Dir. U.S. Govt. Programs  
**Notes:** e/o systems, infrared systems and equipment, night vision equipment

**Organization:** Norman Axelrod, Associates  
**Component:** Norman N. Axelrod Associates Development Laboratory  
**Address:** 28 W 44th St  
New York, NY 10036  
**Contact:** Norman Axelrod  
**Position:** Pres  
**Notes:** Planning, development, and fabrication of electro-optical, laser, and machine vision systems for on-line sensing and control, digital and analog information; computer automated optical systems.

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**Organization:** North Atlantic Industries, Inc.  
**Component:**  
**Address:** 60 Plant Avenue  
Hauppauge, NY 11788-3890  
**Contact:** Marvin Friedman  
**Position:** Director of Marketing  
**Notes:** Thermal imaging

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**Organization:** North Carolina State University  
**Component:** Department of Physics  
**Address:** Raleigh, NC 27695-8202  
**Contact:** P.K. Baumann  
**Position:**  
**Notes:** Authored for 92 MCT workshop "Growth of HgSe and HgCdSe Thin Films by Molecular Beam Epitaxy"

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**Organization:** North Texas State University  
**Component:** Department of Physics  
**Address:** Denton, TX  
**Contact:** Chris L. Littler  
**Position:**  
**Notes:** Authored July 1990 "Two-Photon Absorption Characterization of HgCdTe"

**Organization:** Northrop Corp.  
**Component:** Electronics Systems Division  
**Address:** 600 Hicks Road  
Rolling Meadows, IL 60008-1098  
**Contact:** Laurel Chivari  
**Position:** Manager, Public Relations  
**Notes:** infrared systems and equipment

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**Organization:** Northrop Corporation  
**Component:** Hawthorne Site  
**Address:** 2301 W120th St  
Hawthorne CA 90250-5032  
**Contact:** Kent Kresa  
**Position:** CEO  
**Notes:** Precision inertial sensors and lasers.

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**Organization:** Northrop Corporation  
**Component:** Rolling Meadows Site  
**Address:** 600 Hicks Rd.  
Rolling Meadows, IL 60008  
**Contact:** James Owlswey  
**Position:** VP  
**Notes:** Development of electronic and infrared detection systems.

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**Organization:** Northwestern University  
**Component:**  
**Address:**  
**Contact:** Manijeh Razeghi  
**Position:** Dr.  
**Notes:** Presented at December 1992 DARPA IRFPA Technology Program Reviews  
on "Physics and Performance of GaInP/GaAs Quantum Wells and New  
Infrared III-V Compound InTiSb

**Organization:** Northwick Park Hospital  
**Component:** Dept of Orthopaedics  
**Address:** Watford Road  
Harrow, UNITED KINGDOM  
**Contact:** Leonard Klencerman  
**Position:** Dr.  
**Notes:** active in infrared biomedical thermography

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**Organization:** Notre Dame University  
**Component:** Physics Department  
**Address:** 255 Nieuwland Hall  
Notre Dame, IN 46556  
**Contact:** Hong Luo  
**Position:**  
**Notes:** Attended 1992 MCT workshop

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**Organization:** O R S Automation  
**Component:**  
**Address:** 402 Wall St.  
Princeton, NJ 08540  
**Contact:** Edward Kornstein  
**Position:** Pres  
**Notes:** Controls and guidance directed towards problems in machine vision for individual use.

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**Organization:** Officine Galileo  
**Component:**  
**Address:** V.A. Einstein 35  
50013 Campi Bisenzio, Florence  
ITALY  
**Contact:** Michele Pimpinelli  
**Position:** Marketing  
**Notes:** Night vision, thermal imaging, infrared systems & equipment

**Organization:** Ohio State Univeristy  
**Component:**  
**Address:** 469 Dreese Lab  
2015 Knil Avenue  
Columbus, OH 43210-1210  
**Contact:** Kim Boyer  
**Position:**  
**Notes:** active in infrared process control

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**Organization:** Omnidata International Inc.  
**Component:**  
**Address:** 750 W 200 North, PO Box 3489  
Logan, UT 84321  
**Contact:** Gilbert Larson  
**Position:** Pres  
**Notes:** Development of environmental and industrial sensors, hardware and software for data collection systems.

---

**Organization:** Optical Energy  
**Component:**  
**Address:** 472 Westover Rd  
Stamford, CT 06902  
**Contact:** Gerald Falbel  
**Position:** Chmn  
**Notes:** Research into electro-optical engineering.

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**Organization:** Optical Radiation Corp.  
**Component:**  
**Address:** 1300 Optical Dr.  
Azusa, CA 91702  
**Contact:** Richard Wood  
**Position:** Pres  
**Notes:** Development of electro-optical systems.

**Organization:** Optical Research Associates  
**Component:**  
**Address:** 550 N Rosemead Blvd.  
Pasadena, CA 91107  
**Contact:** Thomas Harris  
**Position:** Pres  
**Notes:** Research in optical design engineering.

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**Organization:** Optical Semiconductors Inc.  
**Component:**  
**Address:** 8 John Walsh Blvd, Suite 421  
Peckskill, NY 10666-5330  
**Contact:** Brian Fitzpatrick  
**Position:** President  
**Notes:** Manufacture of ZnS and ZnSe for infrared systems.

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**Organization:** Optical Technologies, Inc.  
**Component:**  
**Address:** Suite 1200, 360 Herndon Pkwy  
Herndon, VA 22070  
**Contact:** Robert Einzig  
**Position:** Pres  
**Notes:** Research and development of fiber optic sensors for the measurement of physical parameters.

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**Organization:** Optoelectronics- Textron  
**Component:**  
**Address:** 1309 Dynamics St. PO Box 750039  
Petaluma, CA 94975-0039  
**Contact:** Peter McGrath  
**Position:** General Manager  
**Notes:** Manufactures lead salt infrared detectors and related components

**Organization:** Optotex, Ltd.  
**Component:**  
**Address:** 62 Stencic Drive  
Kanata, Ontario, CANADA K2K 2A9  
**Contact:** David Kennedy  
**Position:** Marketing Manager  
**Notes:** GaAs gate arrays, infrared systems and equipment, rf systems and components

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**Organization:** Oriel Corp  
**Component:**  
**Address:** 250 Long Beach Blvd., PO Box 872, Stratford, CT 06497  
**Contact:** Eugene Arthurs  
**Position:** Dir  
**Notes:** Optics and detectors for ultraviolet through infrared systems.

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**Organization:** Osprey Sub-Sea, Inc  
**Component:**  
**Address:** 1225 Stone Dr.  
San Marcos, CA 92069  
**Contact:** Tony Gardiner  
**Position:** Pres  
**Notes:** Night vision equipment and acoustic tracking systems.

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**Organization:** Overhead Door Corp  
**Component:** Horton Automatics Division  
**Address:** 1900 Crown Dr.  
Farmers Branch, TX 75234  
**Contact:** Robert Haugh  
**Position:** Pres  
**Notes:** Microwave and infrared sensing technology.



**Organization:** Overhoff Technologies Corporation  
**Component:**  
**Address:** 1160 US RT 50, PO Box 182  
Millford, OH 45150  
**Contact:** Dr MW Overhoof PhD  
**Position:** Pres  
**Notes:** Infrared, other optical, ultraviolet and nuclear, gaging.

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**Organization:** Oxley Developments Co., Ltd.  
**Component:**  
**Address:** Priory Park  
Ulverston  
Cumbria, UK LA12 9QG  
**Contact:** J.A. Pickup  
**Position:** Sales Admin. Manager  
**Notes:** detectors and sensors, infrared systems and equipment

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**Organization:** Oxley, Inc.  
**Component:**  
**Address:** 25 Business Park Drive  
P.O. Box 814  
Branford, CT 06405  
**Contact:** Audra Kurelaitis  
**Position:** Sales Manager  
**Notes:** c/o systems, night vision, infrared systems & equipment

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**Organization:** Pacer Systems, Inc.  
**Component:**  
**Address:** 900 Technology Park Drive  
Billerica, MA 01803  
**Contact:** Joe Straub  
**Position:** Manager, Signal Processing Systems  
**Notes:** infrared systems & equipment

**Organization:** Paramax Systems Corp.  
**Component:**  
**Address:** 8201 Greensboro Drove, Suite 1000  
McLean, VA 22102  
**Contact:** Gary Teagarden  
**Position:** Dir. Marketing Communications  
**Notes:** passive and active e/o systems, c/o systems, infrared systems and equipment

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**Organization:** Pattern Processing Technologies  
**Component:**  
**Address:** Suite 170, 10025 Valley View Rd.  
Eden Prairie, MN 55344  
**Contact:** Joseph Christenson  
**Position:** Pres  
**Notes:** Product oriented machine vision systems.

---

**Organization:** PCI Inc.  
**Component:**  
**Address:** 50 West Wilmot Street, Unit 3  
Richmond Hill, Ontario L4B 1M5  
CANADA  
**Contact:**  
**Position:**  
**Notes:** REMOTE SENSING SYSTEMS, THERMAL INFRARED,  
MULTISPECTRAL

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**Organization:** Peda-Scan Infrared Service, Inc.  
**Component:**  
**Address:** 1932 Olde Eisenbath Ln.  
Foristell, MO 63348  
**Contact:** Steven Eisenbath  
**Position:** Pres  
**Notes:** Research for industry; thermal evaluation of performance of products.

**Organization:** Perceptronics Incorporated  
**Component:**  
**Address:** 21135 Erwin Street  
Woodland Hills, CA 91365-4198  
**Contact:** Christopher Harz  
**Position:** VP Mkt.  
**Notes:** Has been awarded several government contracts to conduct research and development of computer aided manufacturing processes for IRFPAs.

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**Organization:** Pharm-Eco Laboratories  
**Component:**  
**Address:** 2355 Chain Dr.  
Simi Valley, CA 93065  
**Contact:** DR Kurt Grimm  
**Position:** Pres  
**Notes:** Infrared research, gas chromatography and wet chemical tests.

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**Organization:** Pharos Inc.  
**Component:** Agema Infrared Systems  
**Address:** 595 Skippack Pike  
Blue Bell, PA 19128  
**Contact:** Phillip Smith  
**Position:** Pres  
**Notes:** Infrared measurement systems.

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**Organization:** Phase 4 Infrared  
**Component:**  
**Address:** P.O. Box 2647  
Acton, MA 01720  
**Contact:** R. Gentilman  
**Position:** Pres.  
**Notes:** Manufacturer of ZnS and ZnSe for infrared applications.

**Organization:** Philadelphia Electric Company  
**Component:** Peach Bottom Atomic Power Station  
**Address:** Rd #1 Box 208  
Delat, PA 17314  
**Contact:** Robert N. Wurzbach  
**Position:** Mr.  
**Notes:** active in infrared predictive maintenance

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**Organization:** Philips Infrared Defense Components  
**Component:**  
**Address:** Milbrook Industrial Estate,  
Southampton, SO9 7BH UNITED KINGDOM  
**Contact:**  
**Position:**  
**Notes:** A large producer of 64X64 HgCdTe FPAs. Primarily sold to GEC Sensors for use on a wide variety of systems. Manufactures and supplies infrared detectors based on MCT, TGS, and other materials for use in night vision and industrial applications.

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**Organization:** Photon Energy  
**Component:**  
**Address:** El Paso, TX  
**Contact:**  
**Position:**  
**Notes:** Mass production of CdTe for solar applications.

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**Organization:** Photox Optical Systems  
**Component:**  
**Address:** P.O. Box 274  
Headington, Oxford, OX3 OBJ UNITED KINGDOM  
**Contact:** Jean Aitchison  
**Position:** Gen Mgr.  
**Notes:** Manufacture of GaAs, germanium, silicon, ZnS, and ZnSe for infrared applications.

**Organization:** Photronics Corp.  
**Component:**  
**Address:** 270 Motor Parkway  
P.O. Box 11368  
Hauppauge, NY 11788  
**Contact:** Peter C. Connolly  
**Position:** Business Development Manager  
**Notes:** c/o systems, infrared systems and equipment, night vision

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**Organization:** Picker International, Ltd.  
**Component:** Engineering Dept  
**Address:** P.O. Box 2, East Lane  
Wembley, HA9 7PR, UNITED KINGDOM  
**Contact:** James E. Culley  
**Position:**  
**Notes:** active in infrared biomedical thermography

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**Organization:** Pilkington Optronics  
**Component:**  
**Address:** Caxton Street  
Anniesland, Glasgow GL13 1HZ  
**Contact:** Tom O'Neill  
**Position:** CEO  
**Notes:** Thermal imaging and surveillance systems, laser rangefinders, etc. visible and IR optical systems. Producer of HgCdTe-based FPSs for a variety of military systems, including theIRST on the EFA.

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**Organization:** Pilkington Visioncare  
**Component:** Coburn Optical Industries  
**Address:** Suite 200, 4606 S Garnett  
Tulsa, OK 74146  
**Contact:** John Blocha  
**Position:** President  
**Notes:** Development of infrared products for military and commercial applications.

**Organization:** PJ Wolfson Co Inc  
**Component:**  
**Address:** 50 Kewanee Road  
New Rochelle, NY 10804  
**Contact:**  
**Position:**  
**Notes:** cryogenic equipment

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**Organization:** Plasma Physics Corp.  
**Component:**  
**Address:** PO Box 548  
Locust Valley, NY 11560  
**Contact:** John Coleman  
**Position:** CEO  
**Notes:** Development and manufacture of photoreceptor drums, solar cells and imaging, polymer laminating, and laser isotope separation.

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**Organization:** Plessey Semiconductors Ltd.  
**Component:**  
**Address:** Unit 1, Crompton Road  
Groundwell Ind. Estate, Scindon, Wilts SN2 5AY  
UNITED KINGDOM  
**Contact:** Ernie Pusey  
**Position:** Mkt. Dir.  
**Notes:** Manufacture of a wide variety of HgCdTe-based infrared systems.

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**Organization:** PPM Pure Metals  
**Component:**  
**Address:** 111 Richmond Street, West, Suite 418  
Toronto, Ontario, CANADA M5H 2G4  
**Contact:** Raymond Wary  
**Position:** Sls Mgr  
**Notes:** Manufacture of germanium for infrared technologies.

**Organization:** Preh Electronic Inc.  
**Component:**  
**Address:** 470 E. Main  
Lake Zurich, IL 60047  
**Contact:** Pat Jones  
**Position:** Sales Manager  
**Notes:** Infrared systems & equipment

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**Organization:** Pulse Instruments  
**Component:**  
**Address:** 1234 Francisco Street  
Torrance, CA 90502  
**Contact:** Ron Perry  
**Position:** Dir. Sales and Marketing  
**Notes:** e.o systems, infrared systems & equipment

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**Organization:** Pure Tech Inc.  
**Component:**  
**Address:** P.O. Box 1319  
Carmel, NY 10512  
**Contact:** Earle Ellefsen  
**Position:** Pres.  
**Notes:** Manufacture of CdTe, germanium, silicon, ZnS, and ZnSe for infrared applications.

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**Organization:** Qingdao University  
**Component:** Department of Computer and Information Science  
**Address:** Qingdao, Shandong, CHINA  
**Contact:** Yan Jing-Xuan  
**Position:**  
**Notes:** Co-authored for 1992 SPIE conference on IRFPAs "The Dependence of Fermi Level of HgCdTe on Impurity Concentration and Temperature"

**Organization:** R&D Institute for Semiconductor Devices  
**Component:**  
**Address:** ROMANIA  
**Contact:** E.T. Harlimagean  
**Position:**  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Accurate Method for Neutron Fluence Control Used in Improving Neutron-Transmutation-Doped Silicon Detectors"

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**Organization:** Ramey Aerospace  
**Component:**  
**Address:** Box 39  
Carmel, CA 93924  
**Contact:** Tom Ramey  
**Position:** President  
**Notes:** Thermal Imaging, Infrared systems & equipment

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**Organization:** Ramtek Corporation  
**Component:**  
**Address:** 1525 Atteberry Lane  
San Jose, CA  
**Contact:**  
**Position:**  
**Notes:** remote sensing systems, multispectral

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**Organization:** Ranco, Inc  
**Component:** Paragon Electric Comp.  
**Address:** 606 Parkway Blvd.  
Two Rivers, WI 54241  
**Contact:** T Growcock  
**Position:** VP  
**Notes:** Photo-electric controls.



**Organization:** Raytheon Submarine Signal Division  
**Component:**  
**Address:** 1847 West Main Road  
Portsmouth, RI 02871  
**Contact:** Paul Hitchen  
**Position:** Marketing Comm. Mgr.  
**Notes:** Thermal imaging, detectors and sensors

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**Organization:** Recognition Concepts, Inc.  
**Component:**  
**Address:** 5200 Convair Drive  
Carson City, NV 89706  
**Contact:** Debra Withrow  
**Position:** Advertising Manager  
**Notes:** infrared systems & equipment, imaging software

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**Organization:** Rensselaer Polytechnic Institute  
**Component:** Physics Department and Center for Integrated Electronics  
**Address:** Troy, NY 12180  
**Contact:** E.Y. Lee  
**Position:**  
**Notes:** Co-authored for 1992 meeting of SPIE on IRFPAs "Fundamental Studies of Schottky Barrier IR Detectors by Ballistic Electron Emission Microscopy"

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**Organization:** Rensselaer Polytechnic Institute  
**Component:** ECSE Department  
**Address:** Troy, NY 12180  
**Contact:** Ishwara B. Bhat  
**Position:**  
**Notes:** Co-authored "Improved CdTe Layers on GaAs and Si Substrates, Grown by Atomic Layer Epitaxy" for 1992 MCT Workshop.  
  
Co-authored for 1991 MCT Workshop "Low Temperature Epitaxy of HgTe, CdTe, and HgCdTe Using Flow Modulation Techniques" and "Reduced Metal-Insulator Semiconductor Tunneling in MOCVD MC(111)Te Films"

**Organization:** Research Devices, Inc.  
**Component:**  
**Address:** 121 Ethel Road West  
Piscataway, NJ 08854  
**Contact:** Michael Schneider  
**Position:** Mr.  
**Notes:** AUthored for 1992 SPIE Workshop on MCT "Hybridizing Focal Plane Arrays."

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**Organization:** Research Opportunities, Inc.  
**Component:**  
**Address:** 2200 Hamipola Court Suite 101  
Torrance, CA 90501  
**Contact:** William De La Torre  
**Position:** Mr,  
**Notes:** infrared non-destructive evaluation

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**Organization:** RGB Spectrum  
**Component:**  
**Address:** 950 Marine Village Parkway  
Alameda, CA 94501  
**Contact:** Robert P. Marcus  
**Position:** President  
**Notes:** Thermal imaging

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**Organization:** RICOR Ltd.  
**Component:**  
**Address:** En Haros (IHUD)  
18960  
Israel  
**Contact:** N. Pundak  
**Position:** Mr.  
**Notes:** Authored for 1992 SPIE IRFPA workshop "Miniature Closed Cycle Cooler for FPA Detectors"

**Organization:** Robotron Corp.  
**Component:**  
**Address:** 21300 W Eight Mile Rd.  
PO Box 5090, Southfield, MI 48086  
**Contact:** Leonard Brzozwski  
**Position:** Pres  
**Notes:** Ion processing and other non-traditional heat treating processes, welding of ferrous and non ferrous metals

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**Organization:** Rockwell Engineering Co., Inc.  
**Component:**  
**Address:** 2121 E. 45th St  
Indianapolis, IN, 46205  
**Contact:** Tom Rockwell  
**Position:** CEO  
**Notes:** Optical radiation research.

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**Organization:** Rockwell International Corp.  
**Component:** Government Business Division  
**Address:** 1201 S Second St.  
Milwaukee, WI 53204  
**Contact:** George Brooks  
**Position:** Group Vice President  
**Notes:** Passive electronic components.

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**Organization:** Rockwell International Corporation  
**Component:** Defense Electronics  
**Address:** 3370 Miraloma Ave.  
Anaheim, CA 92803  
**Contact:** J.A. McLuckey  
**Position:** President  
**Notes:** Electro-optical products and systems.

**Organization:** Rockwell International Corporation  
**Component:** Electro-Optical Center  
**Address:** 3370 Miraloma Ave.  
Anaheim, CA 92803  
**Contact:** J.B. Gilpin  
**Position:** Manger Detector Products  
**Notes:** Also their representative in the JM consortium

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**Organization:** Rockwell International Corporation  
**Component:** Industrial Control Group  
**Address:** 1201 S Second St.  
Milwaukee, WI 53204  
**Contact:** Larry Yost  
**Position:** SrVP  
**Notes:** Automation systems and industrial controls.

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**Organization:** Rockwell International Corporation  
**Component:** Science Center  
**Address:** 1049 Camino Do Rios PO Box 1085  
Thousand Oaks, CA 91358  
**Contact:** Joseph Longo  
**Position:** VP  
**Notes:** Basic applied research in electro-optics.

---

**Organization:** Rocky Mountain Instrument Co.  
**Component:**  
**Address:** 1501S Sunset St.  
Longmont, CO, 80501  
**Contact:** Yubong Hahn  
**Position:** Pres  
**Notes:** Manufacture of precision optical components and multilayer thin film coatings.

**Organization:** Rodenstock Industrial Optics  
**Component:**  
**Address:** P.O. Box 14 04 40  
Jsartalstrasse 43  
D-8000 Munich 5, GERMANY  
**Contact:** Mangred Schuck  
**Position:** Senior Manager  
**Notes:** infrared systems & equipment, e/o systems, thermal imaging

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**Organization:** Rosemount Inc.  
**Component:** Aerospace Division  
**Address:** 14300 Judicial Road  
Burnsville, MN 55337  
**Contact:** Sol Mirelez  
**Position:** Marketing Communications Manager  
**Notes:**

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**Organization:** S.I. Vavilov State Optical Institute  
**Component:**  
**Address:** Moscow, RUSSIA  
**Contact:** M.M. Miroshnikov  
**Position:** Mr.  
**Notes:** Authored for 1991 SPIE meeting on Infrared Technology "Infrared in the USSR: Brief Historical Survey of Infrared Development in the Soviet Union"

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**Organization:** Sam Houston State University  
**Component:** Department of Physics  
**Address:** Huntsville, TX 77341  
**Contact:** W. Covington  
**Position:**  
**Notes:** Co-authored "Properties of InAs/(Ga,In)Sb Strained Layer Superlattices Grown on the (111) Orientations" for 1992 MCT Workshop

**Organization:** Sandia National Labs  
**Component:**  
**Address:** ORG 8246  
P.O. Box 969  
Livermore, CA 94511  
**Contact:** Elizabeth A. Fuchs  
**Position:** Ms.  
**Notes:** active in infrared remote sensing

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**Organization:** Santa Barbara Focalplane  
**Component:**  
**Address:** 69 Santa Felicia Drive  
Goleta, CA 93117  
**Contact:** Brett Rosner  
**Position:** Senior Engineer  
**Notes:**

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**Organization:** SAT  
**Component:**  
**Address:** 41, rue Cantagrel  
F-75361 Paris Cedex 13 FRANCE  
**Contact:** Bernard Christophe  
**Position:**  
**Notes:** Along with Thomson CSF, places HgCdTe-based sensors on a variety of military products, including the Rafale fighter. Also produces own InSb-based IRFPAs for use in missile guidance.

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**Organization:** Satcon Technology Corp.  
**Component:**  
**Address:** 12 Emily ST.  
Cambridge, MA 02139-4507  
**Contact:** David Eisenhaure  
**Position:** Pres  
**Notes:** Power electronics and system integration.

**Organization:** Scandinavian Avionics  
**Component:**  
**Address:** Billund Airport  
P.O. Box 59  
7190 Billund, DENMARK  
**Contact:** E.M. Talund  
**Position:** Defece Sales  
**Notes:** infrared systems and equipment, thermal imaging, night vision

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**Organization:** Schlumberger Limited  
**Component:** Statham Transducers  
**Address:** 2230 Statham Rd.  
Oxnard, CA 93033  
**Contact:** Malcom Unsworth  
**Position:** Gmgr  
**Notes:** Micromachined silicone and thin film sensors.

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**Organization:** Schott Glaswerke  
**Component:**  
**Address:** Mainz, Germany  
**Contact:**  
**Position:**  
**Notes:** Manufacture of ZnS and ZnSe for infrared applications.

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**Organization:** Schwartz Electro-Optics  
**Component:**  
**Address:** 3404 N Orange Blossom Trail  
Orlando, FL 32804  
**Contact:** WC. Schwartz  
**Position:** President  
**Notes:** Medical and industrial applications of mid infrared solid state systems.

**Organization:** Science & Engineering Consultants, Inc.  
**Component:**  
**Address:** Suite 300, 1820 discovery St.  
Reston, VA 22090-5610  
**Contact:** Dr Joseph Siewick  
**Position:** CEO  
**Notes:** Research in imaging and remote sensing.

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**Organization:** Science & Technology Corp  
**Component:**  
**Address:** 101 Research Dr., PO Box 7390  
Hampton, VA 23666  
**Contact:** A. Decpak  
**Position:** President  
**Notes:** Development and manufacture of electro-optic sensors.

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**Organization:** Scisco Inc  
**Component:**  
**Address:** 6020 Academy, NE PO Box 25446  
Albuquerque, NM 87125)  
**Contact:** AZ Lazzara  
**Position:** Pres  
**Notes:** Optical sensor data reduction.

---

**Organization:** Scott-White Clinic  
**Component:**  
**Address:** Temple, TX 76501  
**Contact:** Mitchell R. Smigield  
**Position:** Dr.  
**Notes:** active in infrared biomedical thermography



**Organization:** Semcor Inc  
**Component:**  
**Address:** 815 E Gate Dr.  
Mount Laurel, NJ 08054  
**Contact:** Vincent Vidas  
**Position:** CEO  
**Notes:** Optical, infrared, and ultraviolet detection systems.

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**Organization:** Semi-conductor Devices, Inc.  
**Component:**  
**Address:** D.N. Misgav  
20179 ISRAEL  
**Contact:** A. Kepten  
**Position:** Mr.  
**Notes:** Co-authored for 1992 SPIE Workshop on IRFPAs "p-Channel MIS Double-Metal Process InSb Monolithic Unit Cell for Infrared Imaging"

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**Organization:** Semiconductor Processing Co., Inc.  
**Component:**  
**Address:** 409 East First Street  
Boston, MA 02127  
**Contact:** Nicholas Sink  
**Position:** Gen. Mgr.  
**Notes:** Manufacturer of GaAs, germanium, and silicon for infrared applications.

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**Organization:** Sensor Control Corporation  
**Component:** Gentran  
**Address:** 49050 Milmont Dr.  
Fremont, CA 94538  
**Contact:** Paul Page  
**Position:** Mgr  
**Notes:** Infrared temperature measurements.

**Organization:** Sensors Unlimited, Inc.  
**Component:**  
**Address:** Princeton, NJ  
**Contact:** Greg Olsen  
**Position:** Mr.  
**Notes:** Start up company founded by former president and CEO of EPITAXX, Inc., to advance recent developments in III-V compound device tech for sensing and imaging applications in the 1000-3000 nm near-infrared spectrum. Ongoing development projects include a monolithic InGaAs detector for NASA Jet Propulsion Labs and 2000-5000 DFB lasers for Kirtland Air Force Base Phillips Lab.

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**Organization:** Sequa Corporation  
**Component:** Kollsman Military Systems  
**Address:** 220 Daniel Webster  
Merrimack, NH 03054  
**Contact:** Ronald Wright  
**Position:** President  
**Notes:** A variety of infrared research using primarily HgCdTe and InSb. Most HgCdTe is reportedly supplied by Sofradir.

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**Organization:** Servo Corporation of America  
**Component:**  
**Address:** 111 New South Road  
Hicksville, NY 11802  
**Contact:** Alan Doctor  
**Position:** Sales & Marketing Manager  
**Notes:**

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**Organization:** Shandong University  
**Component:** Infrared and Remote Sensing  
**Address:** Jinan, Shandong, CHINA  
**Contact:** Hu Xierong  
**Position:**  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Study of the Recombination Mechanisms and Carrier Lifetimes in HgCdTe Alloy"

**Organization:** Shanghai Institute of Technical Physics  
**Component:** Academia Sinica  
**Address:** China 200083  
**Contact:** Xu Guosen  
**Position:**  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "The Effect of Shockley-Read Recombination on Minority Carrier Lifetime of HgCdTe"

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**Organization:** Siemens AG  
**Component:**  
**Address:** SI SM MA  
Landsluter Strasse 26  
8044 Unterschleissheim, GERMANY  
**Contact:** U. Zinnegger  
**Position:** Marketing Manager  
**Notes:** Infrared systems & equipment, night vision

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**Organization:** Silicon Casting Inc.  
**Component:**  
**Address:** 2616 Mercantile Drive  
Rancho Cordova, CA 95742  
**Contact:** Joseph DeSimone  
**Position:** Pres.  
**Notes:** Manufacturer of silicon for infared applications.

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**Organization:** Silicon Sensor Inc  
**Component:**  
**Address:** Hwy 18 E PO Box 137  
Dodgeville, WI 53533  
**Contact:** Robert Bachner  
**Position:** CEO  
**Notes:** Manufacture of light sensitive products.

**Organization:** Silicon Valley Group, Inc.  
**Component:**  
**Address:** 2240 Ringwood Ave.  
San Jose CA 95131  
**Contact:** Vahne Farkissian  
**Position:** Pres  
**Notes:** Semiconductor wafer processing equipment.

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**Organization:** Silonex Inc  
**Component:** Silonex, Inc  
**Address:** 2150 Ward St.  
Montreal CANADA PQ H4M 1T7  
**Contact:** Alex Kalil  
**Position:** Pres  
**Notes:** Optoelectronics automation of manufacturing.

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**Organization:** Societe Anonyme de Telecommunications  
**Component:**  
**Address:** 41, rue Cantagrel  
75631 Paris, Cedex 13 FRANCE  
**Contact:** D. Lorans  
**Position:** Mr.  
**Notes:** Co-authored for 1992 MCT Workshop "Substrate Issues for Mercury Cadmium Telluride"

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**Organization:** Societe de Fabrication d'Instruments de Mesure  
**Component:**  
**Address:** 13 avenue Ramolfo Garnier  
F91344 Massy Dedex FRANCE  
**Contact:** Ginette Sarrazin  
**Position:** Service Publicite  
**Notes:** thermal imaging, night vision equipment

<b>Organization:</b>	Sofradir
<b>Component:</b>	
<b>Address:</b>	43-47 rue Camille-Pelletan 92290 Chatenay-Malabry, FRANCE
<b>Contact:</b>	
<b>Position:</b>	
<b>Notes:</b>	Thomson CSF owns 40 percent, SAT owns 40 percent, and CEA owns 20 percent of this company, which is France's largest producer of infrared materials. There are currently over 20 programs underway utilizing HgCdTe.

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<b>Organization:</b>	Sogem-Afrimet Inc.
<b>Component:</b>	
<b>Address:</b>	1212 Avenue of the Americas New York, NY 10036
<b>Contact:</b>	Edward Kielty
<b>Position:</b>	Mr.
<b>Notes:</b>	Manufacturer of germanium for infrared applications.

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<b>Organization:</b>	Solar Power Engineering Company
<b>Component:</b>	
<b>Address:</b>	PO Box 91 Morrison, CO 80465
<b>Contact:</b>	Harrison Wroton
<b>Position:</b>	Pres
<b>Notes:</b>	Tracking photovoltaic tracking power systems.

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<b>Organization:</b>	Soreq Nuclear Research Center
<b>Component:</b>	
<b>Address:</b>	ISRAEL
<b>Contact:</b>	D. Eger
<b>Position:</b>	Mr.
<b>Notes:</b>	Co-authored for 1991 SPIE meeting on Growth of IR Materials "Anodic Oxides on HgZnTe"

**Organization:** Southern Illinois Univ School of Medicine  
**Component:**  
**Address:** P.O. Box 9230  
Springfield, IL 62794-9230  
**Contact:** Roger B. Traycoff  
**Position:** Dr.  
**Notes:** active in infrared biomedical thermography

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**Organization:** Southern Methodist University  
**Component:**  
**Address:**  
**Contact:** A.R. Khotanzad  
**Position:**  
**Notes:** Co-authored for 1992 SPIE meeting on Machine Vision "Automated Vision System for INSpection of Wedge Bonds"

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**Organization:** Southern Nuclear Operating Center  
**Component:**  
**Address:** 40 Inverness Center Parkway  
Birmingham, AL 35242  
**Contact:** Albert E. Hammett  
**Position:** Mr.  
**Notes:** active in infrared predictive maintenance

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**Organization:** Southwest Engineering  
**Component:**  
**Address:** 714 First National Bank Bldg.  
Fort Smith, AR 72901  
**Contact:** Myles Friedman  
**Position:** Pres MyPres  
**Notes:** Computer/electronic controls for manufacturing processes.

**Organization:** SPAR Aerospace, Ltd.  
**Component:** Advanced Technology Systems Group  
**Address:** 9445 Airport Road  
Brampton, Ontario, CANADA L6S 4J3  
**Contact:** G. Stan Boyington  
**Position:** Director Business Development  
**Notes:** Infrared systems and equipment, e/o systems, thermal imaging

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**Organization:** Spar Aerospace, Ltd.  
**Component:** Applied Systems Group  
**Address:** 365 March Road  
Kanata, Ontario, CANADA K2K 1X3  
**Contact:** Bruce Hinman  
**Position:** Dir. Business Development and Contracts  
**Notes:** e.o systems, infrared systems & equipment, night vision

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**Organization:** SPEC Industries  
**Component:**  
**Address:** Edison, NJ  
**Contact:**  
**Position:**  
**Notes:** Produces a 1024 X 256 pixel format CCD detector array that doubles the spectral coverage available from SPEC industries

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**Organization:** Speccac Ltd.  
**Component:**  
**Address:** River House, Lagoon Rd.  
St. Mary Cray, Orpington, Kent BR5 3QX  
UNITED KINGDOM  
**Contact:** W.R. Bradbury  
**Position:** Mktg. Dir.  
**Notes:** Manufacture of germanium, silicon, ZnS, and ZnSe for infrared applications.

**Organization:** Spectrogram Corp.  
**Component:**  
**Address:** 385 State St.  
North Haven, CT 06473  
**Contact:** Herbert Gram  
**Position:** Pres  
**Notes:** General research in the field of electro-optics, with a major effort on computer-based optical spectrum analysis as applied to analytical systems.

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**Organization:** Spectron Engineering Inc.  
**Component:**  
**Address:** 255 Yuma Court  
Denver, CO 80223  
**Contact:**  
**Position:**  
**Notes:** remote sensing systems, thermal infrared, multispectral

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**Organization:** Spire Corp  
**Component:**  
**Address:** One Patriots Park  
Bedford, MA 01730  
**Contact:** Roger Little  
**Position:** President  
**Notes:** Photovoltaics, solar cells, compound, semiconductor thin films, and high temperature super conductors. Recently opened a new facility in Oman to produce solar cells. Manufacture of CdTe, GaAs, germanium, and silicon for infrared applications.

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**Organization:** SRI International  
**Component:**  
**Address:** Menlo Park, CA 94025  
**Contact:** M.A. Berding  
**Position:**  
**Notes:** Co-Author of "Native Defect Equilibria in HgZnTe and HgCdTe Alloys" for 1992 MCT Workshop.  
For 1991 Workshop, "Defect Equilibrium in HgTe"



**Organization:** SRS Technology  
**Component:**  
**Address:** Suite 402 3501 Jamboree  
Newport Beach, CA 92660  
**Contact:** MS Sandhu  
**Position:** Pres  
**Notes:** Development of smart sensors, conformal-array antennas, image processing, field measurements, and process control systems.

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**Organization:** Stanford University  
**Component:**  
**Address:** McCullough MS 251  
Stanford, CA 94305  
**Contact:** Jose L. Melendez  
**Position:**  
**Notes:** Attended 1992 MCT Workshop

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**Organization:** State Univ of NY at Buffalo  
**Component:** Dept of Elec & Computer Engineering  
**Address:** Bell Hall  
Buffalo, NY 14214  
**Contact:** Darold C. Wobschall  
**Position:** Dr.  
**Notes:** active in infrared biomedical thermography

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**Organization:** State University of NY at Buffalo  
**Component:** Dept of Biophysical Sciences  
**Address:** 120 Cary Hall  
Buffalo, NY 14214  
**Contact:** Robert A. Spangler  
**Position:** Dr.  
**Notes:** active in infrared biomedical thermography

**Organization:** Stocker & Yale, Inc  
**Component:**  
**Address:** 133 Brimbal Ave.  
Beverly, MA 01915  
**Contact:** J Bickman  
**Position:** Pres  
**Notes:** Optical measuring units for manufacturing controls.

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**Organization:** Structure Probe  
**Component:**  
**Address:** 569 E Gray St., PO Box 656  
West Chester, PA 19381-0656  
**Contact:** Dr Charles Garber  
**Position:** Pres  
**Notes:** X-ray diffraction and thermal analysis.

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**Organization:** Sumitomo Metal Mining Co. Ltd  
**Component:**  
**Address:** Tokyo, Japan  
**Contact:**  
**Position:**  
**Notes:** Manufacture of CdTe and GaAs for infrared applications.

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**Organization:** Sunstrand Corp.  
**Component:** Analytical Productions Division  
**Address:** 820 Linden Ave.  
Rochester, NY 14625  
**Contact:** Harry Stonecipher  
**Position:** Pres  
**Notes:** Image analysis equipment systems and color spectrometry.

**Organization:** SUNY at Stony Brook  
**Component:** Department Materials Sci & Eng  
**Address:** Stony Brook, NY 11794-2275  
**Contact:** Michael Dudley  
**Position:** Mr.  
**Notes:** Attended 1992 MCT conference

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**Organization:** SUNY College of Technology  
**Component:**  
**Address:**  
**Contact:** Abdelrahman Rabie  
**Position:**  
**Notes:** AUthored 1983 "The Use of Sensors in Part Handling" available from S.M.E.

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**Organization:** Superior Evaporants  
**Component:**  
**Address:** 6965 Highway 9  
Felton, CA 95018  
**Contact:** Christopher Toth  
**Position:** President  
**Notes:** Manufacturer of germanium, silicon, ZnS, and ZnSe for infrared systems.

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**Organization:** Surveillance Research Laboratory  
**Component:**  
**Address:** DSTO  
O,I, Bix 1500  
Salisbury, South Australia, 5108  
**Contact:** R.H. Hartley  
**Position:** Mr.  
**Notes:** Co-authored for 1991 MCT Workshop "Real Time Control of the MBE Growth of CdHgTe and CdTe/GhTe Superlattices Using Ellipsometry"

**Organization:** Swedish Space Corporation  
**Component:**  
**Address:** PO Box 4207, S-171 04  
Solna, SWEDEN  
**Contact:**  
**Position:**  
**Notes:** remote sensing systems, thermal infrared

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**Organization:** Syracuse Research Corp.  
**Component:** Defense Electronics Engineering  
**Address:** Merrill Ln.  
Syracuse, NY 13210  
**Contact:** Kenneth Kun  
**Position:** Pres  
**Notes:** Optical and IR systems analysis.

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**Organization:** Target Corp.  
**Component:**  
**Address:** 8400 Lakeview Parkway, Suite 200  
Kenosha, WI 53142-7404  
**Contact:** Carol L. Oxley  
**Position:** President  
**Notes:** infrared systems and equipment, passive and active c/o devices

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**Organization:** Tau Corporation  
**Component:**  
**Address:** Los Gatos, CA  
**Contact:** Donald Hutchinson  
**Position:** Marketing Director  
**Notes:**

**Organization:** Technical Research Center of Finland  
**Component:** Building Laboratory  
**Address:** P.O. Box 167  
SF-90101 Oulu, FINLAND  
**Contact:** Timo Kaupinnen  
**Position:**  
**Notes:** infrared non-destructive evaluation

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**Organization:** Technion University  
**Component:**  
**Address:** Technion City  
Haifa, Israel 3200  
**Contact:** Yael Nemirovsky  
**Position:** IIT Department of Electrical Engineering  
**Notes:** Attended 1992 MCT Workshop

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**Organization:** Technische Universität  
**Component:** Physik-Department E-16  
**Address:** München, D-8046  
GERMANY  
**Contact:** F. Koch  
**Position:**  
**Notes:** Co-authored for 1991 MCT Workshop "Influence of Resonant Defect States on Subband Structures in HgCdTe"

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**Organization:** Technology, Architectural, and Engineering Services  
**Component:** Public Works Canada  
**Address:** Riverside Drive  
Ottawa, Ontario, CANADA K1A 0M2  
**Contact:** Antonio Colantonio  
**Position:** Mr.  
**Notes:** infrared non-destructive evaluation

**Organization:** Tektronix, Inc.  
**Component:**  
**Address:** 26600 Southwest Parkway  
Beaverton, OR 97077  
**Contact:** Robert Dixon  
**Position:** Mr.  
**Notes:** infrared non-destructive evaluation

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**Organization:** Teltron, Inc.  
**Component:**  
**Address:** 2 Riga Ln.  
Birdsboro, PA 19508  
**Contact:** Arthur Mengel  
**Position:** Pres  
**Notes:** Development and production of UV, IR, and TV cameras.

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**Organization:** Texas Brazing Inc  
**Component:** Microwave Products Grp  
**Address:** 400 E Highway 80  
Forney, TX 75126

**Contact:**  
**Position:**  
**Notes:** cryogenic equipment

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**Organization:** Texas Instruments  
**Component:** Central Research Laboratories  
**Address:** P.O. Box 655936, MS 154  
Dallas, TX 75265  
**Contact:** Luigi Colombo  
**Position:** Mr.  
**Notes:**

**Organization:** Texas Instruments  
**Component:** Defense Systems and Electronics Group  
**Address:** POB 660246 MS 3139  
Dallas, TX 75266  
**Contact:** Ronny Dunn  
**Position:** Infrared Program Manager  
**Notes:**

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**Organization:** Texas Instruments  
**Component:** Infrared Devices Laboratory  
**Address:** Dallas, TX 75265  
**Contact:** J.D. Luttmer  
**Position:** Mr.  
**Notes:** The Microelectronics Manufacturing Science and Technology Program at TI is developing a generic semiconductor device manufacturing technology for the mid-1990's. Although the program goal is to develop and demonstrate low volume, fast cycle time, cost effective silicon microelectronic manufacturing the technology also is applicable to MCT, Ga As and other materials.

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**Organization:** Texas Instruments  
**Component:** Infrared Materials Laboratory  
**Address:** POB 655936 MS150  
Dallas, TX 75265  
**Contact:** M.A. Kinch  
**Position:** Dr.  
**Notes:** Head of their IR producibility effort; representative to JM consortium on producibility

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**Organization:** Texas Instruments Inc  
**Component:** Central Research Laboratories  
**Address:** PO Box 655936, MS 136  
Dallas, TX 75265  
**Contact:** Robert Stratton  
**Position:** VP  
**Notes:** Production of HgCdTe-based infrared imagers.

**Organization:** Texas Tech University  
**Component:** Department of Physics and Engineering Physics  
**Address:** Lubbock, TX 79409-1051  
**Contact:** Charles W. Myles  
**Position:**  
**Notes:** Co-authored for 1991 MCT workshop "Critical Stress of HgCdTe Solid Solutions." and "Microhardness of Hg-Containing II-VI Alloys"

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**Organization:** Textron Defense Systems  
**Component:**  
**Address:** 201 Lowell Street  
Wilmington, MA 01887  
**Contact:** Nancy Parker  
**Position:** Business Communications  
**Notes:** Infrared systems and equipment, GaAs arrays, active and passive c/o systems, detectors and sensors

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**Organization:** Textron Inc  
**Component:** Sensor Systems  
**Address:** 201 Lowell St  
Wilmington, MA 01887  
**Contact:** Robert Wilson  
**Position:** VP  
**Notes:** Sensor systems for target discriminations, detections, and tracking.

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**Organization:** The Aerospace Corporation  
**Component:** Electronic Technology Center  
**Address:** P.O. Box 92957  
Los Angeles, CA 90009  
**Contact:** R.C. Lacoe  
**Position:** Mr.  
**Notes:** Co-authored for 1992 SPIE workshop on IRFPAs "Modified Wuantum Well Infrared Photodector Designs for High Temperature and Long Wavelength Operation"



**Organization:** The Boeing Company  
**Component:**  
**Address:** 7755 E Marginal Way S, PO Box 3707 Seattle, WA 98124  
**Contact:** Frank Schrontz  
**Position:** CEO  
**Notes:** Research in the field of aerospace including sensor systems.

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**Organization:** The Pyrometer Instrument Company  
**Component:**  
**Address:** 234 Industrial Pkwy.  
Northvale, NJ 07647  
**Contact:** EK Matthews  
**Position:** Pres  
**Notes:** Design and production of infrared temperature measurement systems.

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**Organization:** Thermo Electron Corp.  
**Component:**  
**Address:** 101 First Ave.,  
Waltham, MA 02254  
**Contact:** George Hatsopoulos  
**Position:** Pres  
**Notes:** Production of optics, electro-optics, electro-acoustic systems.

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**Organization:** Thomson Components & Tubes Corp  
**Component:** TCS Division  
**Address:** 40 G Commerce Eay  
Totowa, NJ 07511  
**Contact:** Gregg Herbison  
**Position:** National Sales Manager  
**Notes:** Infrared systems and equipment, GaAs gate arrays, detectors & sensors

**Organization:** Thomson Composants Militaires et Spatiaux  
**Component:**  
**Address:** 50, rue j.-Pierre Thimbaud  
Courbevoie, 92402, FRANCE  
**Contact:** R. Besamat  
**Position:** Chief Executive  
**Notes:** Manufactures semiconductors for the high end professional, military, and space  
amrkets. Oferrs linear and matrtric CCDs.

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**Organization:** Thomson CSF  
**Component:**  
**Address:** Cedex 67  
F-92056 Paris- La Defense  
FRANCE  
**Contact:**  
**Position:**  
**Notes:** Producer of a variety of HgCdTe-based military sensors, including theIRST  
for the Rafale.

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**Organization:** Thorton Associates Inc  
**Component:**  
**Address:** 1432 Main St.  
Waltham, MA 02154  
**Contact:** Charles Staples  
**Position:** Pres  
**Notes:** Production of electronic control devices.

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**Organization:** Timeco Inc  
**Component:**  
**Address:** 1035 26th St.  
Huntington, WV 25705  
**Contact:** Wilson Twohig  
**Position:** Pres  
**Notes:** Timing controls, photoelectric controls, and load sensors.

**Organization:** Titronics Inc  
**Component:**  
**Address:** RR 1, Box 53B  
Oxford, IA 52322  
**Contact:** Roger Titrone  
**Position:** Pres  
**Notes:** Infrared terrain scanning.

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**Organization:** Tomsk Polytechnic Institute  
**Component:**  
**Address:** Tomsk, RUSSIA  
**Contact:** V.P. Vavilov  
**Position:**  
**Notes:** Authored for 1991 SPIE meeting on IR Technology "Soviet IR IMagers and Their Applications: Short State of the Art"

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**Organization:** Toshiba Corporation  
**Component:** Research and Development Center  
**Address:** Komukai Works  
Kawasaki, Japan  
**Contact:** K. Shigenaka  
**Position:** Mr.  
**Notes:** Co-authored for 1992 MCT Workshop "Effects of Growth Rate and Mercury Partial Pressure on Twin Formation in HgCdTe (111) Layers Grown by MOCVD"

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**Organization:** Total Vision Photonics  
**Component:**  
**Address:** 39 Vaughn Street, Suite 202  
Ottawa, CANADA K1M1W9  
**Contact:** Peter Gaylord  
**Position:** Mr.  
**Notes:** active in infrared process control

**Organization:** TRW Inc  
**Component:** TRW Electronic Systems Group  
**Address:** E Bldg., Rm 5076, One Space Park  
Redondo Beach, CA 90278  
**Contact:** Timothy Hannemann  
**Position:** VP  
**Notes:** Development of advanced infrared sensor technologies.

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**Organization:** TSI Thermo-Scan Energy Management  
**Component:**  
**Address:** 15658 North Gray Road, Box 705  
Carmel, IN 46032  
**Contact:** Phillip C. McMullan  
**Position:** Mr.  
**Notes:** active in infrared predictive maintenance

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**Organization:** Tsing-Hua University  
**Component:** Material Center  
**Address:** 101, Sec 2 Kunag-Rd.  
Hsingchu, Taiwan, ROC  
**Contact:** Chao Huang  
**Position:**  
**Notes:**

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**Organization:** Tufts University  
**Component:** Electro-Optics Technology Center  
**Address:** Medford, MA 02155  
**Contact:** Jorge Jimenez  
**Position:**  
**Notes:** Co-authored for 1992 meeting of SPIE on IRFPAs "Fundamental Studies of Schottky Barrier IR Detectors by Ballistic Electron Emission Microscopy"

**Organization:** UDT Sensors Inc  
**Component:**  
**Address:** 12525 Chadron Ave.  
Hawthorne, CA 90250  
**Contact:** Deepak Chopra  
**Position:** Pres  
**Notes:** Development of light-based sensors.

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**Organization:** Union Miniere  
**Component:**  
**Address:** A. Greinerstraat 14  
B-2660 Hoboken-Belgium  
**Contact:** Guy Knockaert  
**Position:** Technico-commercial Manager  
**Notes:**

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**Organization:** United Mineral and Chemical Corp.  
**Component:**  
**Address:** 1100 Valley Brook Avenue  
Lyndhurst, NJ 07071-3608  
**Contact:** Irwin Drangel  
**Position:** Sales Manager  
**Notes:** Manufacture of CdTe, GaAs, germanium, and ZnS for infrared applications.

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**Organization:** United Technologies Corp.  
**Component:** United Technologies Research Center  
**Address:** Silver Ln.  
East Hartford, CT 06108  
**Contact:** Dr Wayne Burwell  
**Position:** Dir. R&D  
**Notes:** Development of advanced infrared electronic systems.

**Organization:** Unitron, Inc  
**Component:**  
**Address:** 170 Wilbur Pl., PO Box 469  
Bohemia NY 11716  
**Contact:** Thomas Zappetti  
**Position:** Pres  
**Notes:** Development of advanced optical systems.

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**Organization:** Univ of Illinois College of Medicine  
**Component:** Carle Foundation  
**Address:** 611 West Park Street  
Urbana, IL 61801  
**Contact:** Ralph Nelson  
**Position:** Dr.  
**Notes:** active in infrared biomedical thermography

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**Organization:** Univeristy of Texas at Arlington  
**Component:** Dept of Computer Science Engineering  
**Address:** P.O. Box 19015  
Arlington, TX 76019-0015  
**Contact:** Diane Cook  
**Position:**  
**Notes:** active in infrared process control

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**Organization:** Universal Energy Systems  
**Component:**  
**Address:** 4401 Dayton-Xenia Rd.  
Dayton, OH 45432  
**Contact:** Shan Joshi  
**Position:** Pres  
**Notes:** Development and application of laser and electro-optic systems.

**Organization:** Universal Sensors, Inc.  
**Component:**  
**Address:** Suite D, 5258 Veterans Blvd.  
Metairie, LA 70006  
**Contact:** George Guilbalt  
**Position:** President  
**Notes:** Development of advanced biosensors and immunosensors for medical applications.

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**Organization:** Universal Technology Corp.  
**Component:**  
**Address:** 4031 Colonel Glenn Hwy.  
Dayton, OH 45431  
**Contact:** Robert Guyton  
**Position:** Pres  
**Notes:** Development of advanced manufacturing technologies for metal working and electronic research and development.

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**Organization:** Universitat de Barcelona  
**Component:**  
**Address:** Avd. Diagonal 647  
E-08028 Barcelona, SPAIN  
**Contact:** Elisanda Roca  
**Position:**  
**Notes:** Co-author at 1992 SPIE IRFPA meeting of "Comparative Study of SWIR and MWIR Schottky-barrier Imagers"

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**Organization:** University of Arizona  
**Component:** Arizona Remote Sensing Center  
**Address:** 845 North Park Avenue  
Tucson, AZ 45719  
**Contact:** Stuart E. Marsh  
**Position:** Mr.  
**Notes:** active in infrared remote sensing

**Organization:** University of Arizona  
**Component:** Optical Sciences Center  
**Address:** Tucson, AZ 85721  
**Contact:** E.L. Derenial  
**Position:**  
**Notes:** Co-Author in 1992 SPIE meeting of "Development of a High-Speed PtSi IRCCD Camera System"

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**Organization:** University of Arizona  
**Component:** Optical Sciences Center  
**Address:** Tucson, AZ 85721  
**Contact:** Thorsten Graeve  
**Position:** Mr.  
**Notes:** active in infrared process control

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**Organization:** University of California in Los Angeles  
**Component:**  
**Address:**  
**Contact:** T. Maxworthy  
**Position:**  
**Notes:** Authored February 1991 study "Laboratory Modelling of the Dynamics of Coastal Upwelling" which studies the dynamics of the filamentary structures that have been repeatedly observed by satellite by IR imagery taken from the West Coast.

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**Organization:** University of California, Los Angeles  
**Component:** Department of Chemical Engineering  
**Address:** Los Angeles, CA 90024-1592  
**Contact:** F. Hicks  
**Position:**  
**Notes:** Co-authored for 1991 MCT Workshop "Photoassisted Organometallic VPE on CdTe"



**Organization:** University of California, Los Angeles  
**Component:** Electrical Engineering Department  
**Address:** Los Angeles, CA 90024  
**Contact:** C.R. Viswanathan  
**Position:**  
**Notes:** For 1991 MCT Workshop, wrote "Compositional Analysis of HgCdTe Epitaxial Layers Using Secondary Ion Mass Spectrometry"

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**Organization:** University of Erlangen  
**Component:**  
**Address:** Erlangen, GERMANY  
**Contact:** W.A. Cabanski  
**Position:**  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Electronic and Optical Properties of Silicide/ Silicon IR Detectprs"

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**Organization:** University of Florida  
**Component:** Department of Electrical Engineering  
**Address:** Gainesville, FL 32611  
**Contact:** Sheng S. Li  
**Position:**  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "A Noval Grating Coupled Step-Bound-to-Miniband Transition InGaAs/GaAs/AlGaAs Multiquantum Well Infrared Photodetector"

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**Organization:** University of Houston  
**Component:** Department of Physics and Space Vacuum Epitaxy Center  
**Address:** Houston, TX 77204  
**Contact:** T.D. Golding  
**Position:**  
**Notes:** Co-authored "Properties of InAs/(Ga,In)Sb Strained Layer Superlattices Grown on the (111) Orientations" for 1992 MCT Workshop

**Organization:** University of Illinois at Chicago  
**Component:** Microphysics Laboratory, Physics Department  
**Address:** P.O. Box 4348  
Chicago, IL 60680  
**Contact:** Y.P. Chen  
**Position:**  
**Notes:** Authored "Structure of CdTe(111)B grown by MBE on Misoriented Si(001)"  
for 1992 MCT Workshop.  
For 1991 Workshop, "Current Status of Direct Growth of CdTe and HgCdTe  
on Silicon by MBE"

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**Organization:** University of Maryland  
**Component:**  
**Address:** College Park, MD  
**Contact:** J.R. Anderson  
**Position:**  
**Notes:** Co-authored 1987 study "Magnetophonon Effect in HgCdTe"  
Co-authored 1987 study "Phase Differences between Quantum Oscillations of  
the Magnetoresistance and the Hall Effect in HgMnTe and HgCdTe"

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**Organization:** University of Maryland  
**Component:** Maryland Agricultural Experiment Station  
**Address:** College Park, MD 20742  
**Contact:** Gary Stutte  
**Position:** Mr.  
**Notes:** active in infrared remote sensing

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**Organization:** University of Maryland  
**Component:** Medical School  
**Address:** Baltimore, MD  
**Contact:** Joseph Lakowicz  
**Position:** Mr.  
**Notes:** Speaking at OE/LASE Laser Market '93 seminar on wavelength requirements  
for medical diagnostics in the near-infrared spectral regions. The wavelength  
in such applications determines not only which molecules will absorb the  
light, but how deeply the light will penetrate biological tissues.

**Organization:** University of Michigan  
**Component:** Department of Electrical Engineering and Computer Science  
**Address:** Ann Arbor, MI 48109  
**Contact:** J. Singh  
**Position:**  
**Notes:** Co-Author of "Recent Advances on HgCdTe Mid Infrared Diode Lasers" for 1992 MCT Workshop.

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**Organization:** University of Minnesota School of Medicine  
**Component:** Minneapolis Clinic of Neurology  
**Address:** 305 East Nichola Boulevard  
Ridgeview Medical Bldg, Suite 185  
Burnsville, MN 55337  
**Contact:** Jack Hubbard  
**Position:** Dr.  
**Notes:** active in infrared biomedical thermography

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**Organization:** University of Montana  
**Component:** School of Forestry  
**Address:** Missoula, MT 59812  
**Contact:** Lars L. Pierce  
**Position:** Mr.  
**Notes:** active in infrared remote sensing

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**Organization:** University of Nebraska  
**Component:** Center for Electro-Optics  
**Address:** Lincoln, NE 69588  
**Contact:** Ram M. Narayanan  
**Position:**  
**Notes:** active in infrared remote sensing

**Organization:** University of New South Wales  
**Component:** School of Physics  
**Address:** Kensington 2033 AUSTRALIA  
**Contact:** M. Gal  
**Position:**  
**Notes:** Co-Authored "In-Situ Ellipsometric Measurements of the MBE Growth of CdTe/HgTe and CdTe/AnTe Superlattices" for 1992 MCT Workshop

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**Organization:** University of North Texas  
**Component:** Department of Physics  
**Address:** Denton, TX 76203  
**Contact:** C.L. Littler  
**Position:**  
**Notes:** Co-Authored "Heavily Accumulated Surfaces of MCT Detectors: Theory and Experiment" for 1992 MCT Workshop.  
For 1991 Workshop, "Investigation of Mercury Interstitials in MCT alloys Using Resonant Impact-Ionization Spectroscopy"

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**Organization:** University of North Carolina at Chapel Hill  
**Component:** Department of Physics and Astronomy  
**Address:** Chapel Hill, NC 27599-3255  
**Contact:** J.C. Austin  
**Position:**  
**Notes:** Co-Authored "Observation of Indium-Vacancy and Indium Hydrogen Interactions in (HgCd)Te Using PAC"

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**Organization:** University of Notre Dame  
**Component:**  
**Address:** Notre Dame, IN 46556  
**Contact:** J.K. Furdyna  
**Position:**  
**Notes:** On Program Committee of 1992 MCT Workshop  
For 1991 Workshop co-authored "Magnetic Generation of Electrons and Holes in Semimetallic HgTe-CdTe Superlattices"

**Organization:** University of Pittsburgh at Greensburg  
**Component:**  
**Address:**  
**Contact:** Guy M. Nicoletti  
**Position:**  
**Notes:** Authored 1988 "Optoelectronic Proximity Sensors for Automated Deburring"

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**Organization:** University of Southampton  
**Component:** Engineering Materials  
**Address:** Southampton, SO9 5NH  
UNITED KINGDOM  
**Contact:** N.A. Archer  
**Position:**  
**Notes:** Authored "Growth Method, Composition, and Defect Structure Dependence of Mercury Diffusion in CdHgTe" for 1992 MCT Workshop.

---

**Organization:** University of Southern California  
**Component:** Department of Materials Science and Engineering  
**Address:** Los Angeles, CA 90089-0241  
**Contact:** K.T. Chang  
**Position:**  
**Notes:** Co-authored for 1991 MCT Workshop "Ordered Phase in (HgCd)Te Grown by LPE on CdTe (111)B Substrate"

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**Organization:** University of West Australia  
**Component:** Department of EE  
**Address:** Nedlands, Perth, Western Australia 6009  
**Contact:** Lorenzo Faraone  
**Position:**  
**Notes:** Attended 1992 MCT conference

**Organization:** University of Wurzburg  
**Component:**  
**Address:** GERMANY  
**Contact:** R.N. Bicknell-Tassius  
**Position:** Mr.  
**Notes:** Authored for SPIE 1991 meeting on Growth of IR materials "Growth of CdTe-CdMnTe Heterostructures by MBE"

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**Organization:** USDA - ARS  
**Component:** Remote Sensing Research Unit  
**Address:** 2413 E. Highway 83  
Weslaco, TX 79586  
**Contact:** David E. Escobar  
**Position:** Mr.  
**Notes:** active in infrared remote sensing

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**Organization:** UTI Instruments  
**Component:**  
**Address:**  
**Contact:** Hugh Danaher  
**Position:** Mr.  
**Notes:**

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**Organization:** Vicon Infrared  
**Component:**  
**Address:** Four Seneca Court  
Acton, MA 01720  
**Contact:** Ralph Rotolante  
**Position:** Mr.  
**Notes:** Former founder and president of the now defunct New England Research Center. Private consultant

**Organization:** Vinten-Penarroya Inc.  
**Component:**  
**Address:** 17151 Newhope Street, Suite 208  
Fountain Valley, CA 92708  
**Contact:** F. Fernandez  
**Position:** President  
**Notes:** Manufacture of germanium for infrared applications.

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**Organization:** Virginia Polytechnic Institute  
**Component:**  
**Address:**  
**Contact:** P.R. Norton  
**Position:**  
**Notes:** On Program Committee of 1992 MCT Workshop.  
On Program Committee of 1991 MCT Workshop, as a representative of SBRC.

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**Organization:** Virginia University  
**Component:** Department of Electrical Engineering  
**Address:** Charlottesville, VA  
**Contact:** Boris Gelmont  
**Position:**  
**Notes:** Co-authored May 1992 report "Monte Carlo Simulation of Electron Transport in HgCdTe"

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**Organization:** Visidyne Inc  
**Component:**  
**Address:** 10 Corporate Pl.,  
Burlington, MA 01803  
**Contact:** J Carpenter  
**Position:** Pres  
**Notes:** Development of electro-optical instrumentation.

**Organization:** Vision Harvest  
**Component:**  
**Address:** HCR Box 36  
Hatch, NM 87937  
**Contact:** Craig Davidson  
**Position:** Mr.  
**Notes:** active in infrared process control

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**Organization:** Wahl Instruments, Inc.  
**Component:**  
**Address:** 5750 Hunnum Ave.,  
Culver City, CA 90231  
**Contact:** Carol Smith  
**Position:** Ms.  
**Notes:** Production of non-contact IR thermometers for industrial processes.

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**Organization:** Washington University  
**Component:** Department of Materials Science and Engineering  
**Address:** Seattle, WA  
**Contact:** Ryoichi Kikuchi  
**Position:**  
**Notes:** Authored February 1988 study "Migration and Stability of HgCdTe Lattice Defects"

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**Organization:** Wayne State University  
**Component:**  
**Address:** Detroit, MI  
**Contact:** L.D. Favro  
**Position:**  
**Notes:** Authored in 1990 a 7 page "Noise Suppresion in IR Thermal-Wave Video Images by Real-Time Processing in Synchronism with Active Stimulation of the Target"



**Organization:** Wayne State University  
**Component:** Department of Physics  
**Address:** Detroit MI  
**Contact:** S. Goettig  
**Position:**  
**Notes:** Co-authored 1990 "FOrmation Mechanisms of Interstitial Defect States"

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**Organization:** Wayne State University  
**Component:** Dept of Physics and Inst for Manufacturing Research  
**Address:** Detroit, MI 48202  
**Contact:** D.J. Crowther  
**Position:**  
**Notes:** infrared non-destructive evaluation

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**Organization:** Wayne State University  
**Component:** Institute for Manufacturing Research  
**Address:** Detroit, MI  
**Contact:** T. Ahmed  
**Position:**  
**Notes:** Authored in 1991 an 8 page "Infrared Thermal Wave Studies of Composites."  
Authored 1990 paper entitled "Real-time Thermal wave Imaging of Plasma-Sprayed Coatings and Adhesive Bonds Using a Box-Car Video Technique."  
Authored 1989 paper "Parallel Thermal Wave IR Video Imaging of Polymer Coatings and Adhesive Bonds." Authored 1987 paper "Characterization of Plasma Sprayed Coatings Using Thermal Wave IR Video Imaging."

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**Organization:** West Virginia University  
**Component:**  
**Address:** P.O. Box 6315  
Morgantown, WV 26506-6315  
**Contact:** Thomas H. Myers  
**Position:** Physics Department  
**Notes:** Attended 1992 MCT Workshop

**Organization:** Westinghouse  
**Component:** Research Center  
**Address:** Westinghouse Building, Gateway Center  
Pittsburg, PA 15222  
**Contact:**  
**Position:**  
**Notes:** Producer of a variety of PtSi staring IRFPAs for the Army. The Center is also involved in DARPA's electronic sciences program.

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**Organization:** Westinghouse Corp.  
**Component:** Advanced Technology Division  
**Address:** Baltimore, MD 21203  
**Contact:** Arthur S. Jensen  
**Position:** Mr.  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Superconductive Circuits for On-FPA IR Digital Signal Processing"

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**Organization:** Westinghouse Electric Corp.  
**Component:** Electronics Systems Division  
**Address:** P.O. Box 17319  
MS A255  
Baltimore, MD 21203-6812  
**Contact:** Ann Grizzel  
**Position:** Manager, Public Relations  
**Notes:** Infrared systems and equipment, detectors and sensors, c/o systems

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**Organization:** Westmark Systems, Inc  
**Component:** Tracor-GIE  
**Address:** 1652 W 820 North  
Provo, UT 84601  
**Contact:** William Wallace  
**Position:** Pres  
**Notes:** Development of infrared and far-infrared systems.

**Organization:** Whittaker Electronics  
**Component:**  
**Address:** 1785 Voyager Avenue  
Simi Valley, CA 93063-3349  
**Contact:** R. La Polla  
**Position:** Marketing Manager  
**Notes:** infrared systems & equipment

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**Organization:** Willey Corporation  
**Component:**  
**Address:** PO Box 670  
Melbourne, FL 32902  
**Contact:** Ronald Willey  
**Position:** Pres  
**Notes:** R&D of unique and sophisticated infrared reflectance spectrophotometry.

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**Organization:** Williamson Corporation  
**Component:**  
**Address:** 70 Domino Dr., PO Box 1270  
Concord, MA 01742  
**Contact:** CF Langenhagen  
**Position:** Pres  
**Notes:** R&D of infrared radiometers for temperature measurement and control.

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**Organization:** Worcester Polytechnic Institute  
**Component:**  
**Address:** Worcester, MA 01609  
**Contact:** L.R. Ram-Mohan  
**Position:**  
**Notes:** Co-authored for 1991 MCT Workshop "Magnetic Generation of Electrons and Holes in Semimetallic HgTe-CdTe Superlattices"

**Organization:** Worcester Polytechnic Institute  
**Component:** Department of Physics  
**Address:** Worcester, MA 01609  
**Contact:** L.R. Ram-Mohan  
**Position:**  
**Notes:** Co-Author of "States Confined in the Barriers of Type-III HgTe/CdTe Superlattices" for 1992 MCT Workshop

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**Organization:** Worcester Institute of Technology  
**Component:** Center for Imaging Science  
**Address:** One Lomb Memorial Drive  
Rochester, NY 14623  
**Contact:** James R. Schmitt  
**Position:** Mr.  
**Notes:** active in infrared remote sensing

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**Organization:** Xedar Corp  
**Component:**  
**Address:** 2500 Central Avenue  
Boulder, CO 80301  
**Contact:** Cindy Zeidler  
**Position:** Ms.  
**Notes:** infrared non-destructive evaluation

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**Organization:** Young Design  
**Component:**  
**Address:** 7110 Sea Cliff Road  
McLean, VA 22101  
**Contact:** Michael F. Young  
**Position:** President  
**Notes:** Infrared systems & equipment

## Appendix E

### Professional and Trade Organizations

#### Serving the Infrared Community

##### Air Force Association

1501 Lee Highway  
Arlington, VA 22209  
(703) 247-5800

##### American Association of Engineering Societies

1111 19th Street, NW, #608  
Washington, DC 20036  
(202) 296-2237

##### American Chemical Society

1155 16th Street, NW  
Washington, DC 20036  
(202) 872-4600

##### American Consulting Engineers Council

1015 15th St., NW, #802  
Washington, DC 20005  
(202) 347-7474

##### American Defense Preparedness Association

2101 Wilson Boulevard, Suite 400  
Arlington, VA 22201  
(703) 522-1820

Their annual symposium and exhibition on night operations brings together experts on IR technologies in night vision equipment, military applications of smart sensors, technology for autonomous weapons, and electro-optic applications. All sessions are unclassified. It is scheduled usually in September.

American Electronics Association  
1225 Eye Street, NW #950  
Washington, DC 20005  
(202) 682-9110

American Gear Manufacturers Association  
1500 King Street, #201  
Alexandria, VA 22314  
(703) 684-0211

American Institute of Aeronautics and Astronautics  
370 L'Enfant Promenade, SW #1000  
Washington, DC 20024  
(202) 646-7400

American Institute of Chemical Engineers  
1707 L Street, NW #333  
Washington, DC 20036  
(202)223-0650

American Institute of Physics  
335 E. 45th Street  
New York, NY 10017  
(212) 661-9404

Publishes the Journal of Vacuum Science and Technology, which prints articles on state of the art technological breakthroughs on semiconductor materials, much of it on Mercury cadmium telluride. Also help organize annual US Workshop on Physics and Chemistry of Mercury Cadmium Telluride and Other II-VI Compounds, held usually in October.

American Institute of Thermography  
138 Church Street, NE, Suite C  
Vienna, VA 22180  
(703) 938-6140

Kathryn Werner heads the office. Recently formed to inform public about prospects for infrared biomedical imaging. Its members are predominantly researchers at universities and at small, start-up businesses. Chairman is Dr. Michael Anbar at the State University of New York in Buffalo. Publishes occasional Journal of Thermology which is on hold until funding can be found to print it. Apparently funding was pulled from the IR imaging companies which sought military business rather than what they saw as the small biomedical market.

American Iron and Steel Institute  
1101 17th Street, NW, #1300  
Washington, DC 20036  
(202) 452-7100

American Machine Tool Distributors Association  
1335 Rockville Park, #300  
Rockville, MD 20852  
(202) 738-1200

American Paper Institute  
1250 Connecticut Avenue, NW #210  
Washington, DC 20036  
(202) 463-2420

American Public Power Association  
2301 M Street, NW, #300  
Washington, DC 20037  
(202) 775-8300

American Society of Mechanical Engineers  
1828 L Street, NW #906  
Washington, DC 20036  
(202) 785-3756

American Society for Metals International  
Materials Park, OH 44073  
(216) 338-5151

This is the major metallurgical society worldwide. Since IRFPAs are being increasingly used in metallurgy for thermal imaging of steel, aluminum, etc. in real-time as they roll off the production line, this society may become valuable. They do not have a working group, however, concerned with non-destructive testing.

American Society for Nondestructive Testing  
4153 Arlingdale Plaza  
Columbus, OH 43228  
(614) 274-6003

Thermal sensors are becoming increasingly important in non-destructive testing, and the ASNT is taking an interest in infrared technology. Although it has no working groups or smaller societies on IR work, it will be able to refer us to people in specific industries who can speak about using IR sensors in their production systems.

American Society for Photogrammetry and Remote Sensing  
5401 Grosvenor Lane #210  
Bethesda, MD 20814  
(301) 493-0290

American Society for Testing and Materials  
1916 Race Street  
Philadelphia, PA 19103  
(215) 299-5400

Among the oldest and broadest based organizations in its field in the U.S. They have no working groups or publications which address the use of IRFPAs or IR technology in industrial sensors, but they are taking an increasing interest in the industrial applications and will offer names in specific industries if we need them.

American Society for Quality Control  
611 E. Wisconsin Avenue  
Milwaukee, WI 53202-4606  
(414) 272-8575

Since they are a society to which quality control managers belong, IR sensor may play a growing part in their field. They have both a measurement division, led by Joel Simmons at 301-975-2005, and an inspections division, headed by Charles Carter at 214-234-3296. They have both been extremely helpful in locating articles and experts.

Armed Forces Communications and Electronics Association  
4400 Fair Lakes Court  
Fairfax, VA 22033  
(703) 631-6100

Association for Manufacturing Technology  
7901 Westpark Drive  
McLean, VA 22102  
(703) 893-2900

Association of Science- Technology Centers  
1025 Vermont Avenue, NW #500  
Washington, DC 20005  
(202) 783-7200

Association of the United States Army  
2425 Wilson Boulevard  
Arlington, VA 22201  
(703) 841-4300



**Center for Non-Destructive Evaluation**

Iowa State University  
1915 Scholl Road  
Ames, IA 50011

This center organizes the annual Review of Progress in Quantitative Nondestructive evaluation conference, and publishes its proceedings. The conference serves as an annual meeting place for engineers and scientists working on highly analytical and complex nondestructive evaluation. Although ultrasonic techniques are more often discussed, specifically eddy current, thermal imaging has been discussed increasingly. This conference and its attendees have been at the forefront of aging aircraft inspection.

**Chemical Manufacturers Association.**

2501 M Street, NW 20037  
Washington, DC 20037  
(202) 887-1100

**Electric Power Research Institute**

1019 19th Street, NW #1000  
Washington, DC 20036  
(202) 872-9222

**Electronics Industries Association**

2001 Pennsylvania Avenue, NW #1100  
Washington, DC 20006  
(202) 457-4900

**Infrared Information Analysis Center**

P.O. Box 134001  
Ann Arbor, MI 48113-4001  
(313) 994-1200

At the Environmental Research Institute of Michigan, the IRIA is a DTIC- sponsored DoD Information Analysis Center. It is the leading training facility for program managers in military-industrial work on classified IR projects. It can not disburse any papers or professional lists or program of events until we have a DTIC identification number.

**Infraspection Institute**

1971 Shelburne Road Suite C  
Shelburne, VT 05482  
(802) 985-2500

Headed by Paul Grover, the Institute supports those who use and provide infrared thermographic services through their training, continuing education, and certification programs. It is a leader in training inspectors who use IR in their factories and plants. Their newsletter is seasonal, and called simply the "Infraspection Institute Newsletter."

**Institute for Electrical and Electronic Engineers (IEEE)**

345 East 47th Street  
New York NY 10017  
(212) 705-7900

A society which has a wealth of information on IR technologies, especially concerning applications. They have many working groups which publish papers with a decidedly technical bent, and working groups which may be of interest are "Aerospace and Electronic Systems," "Components, Hybrids, and Manufacturing Technology," and "Lasers and Electro-Optics." They have a yearly meeting on "Thermosense," organized usually by Professor Bill Wolfe at the University of Arizona.

**Institute of the Ironworking Industry**

1750 New York Avenue, NW #400  
Washington, DC 20006  
(202) 783-3998

**International Society for Optical Engineering (SPIE)**

P.O. Box 10  
Bellingham, WA 98227-0010

The oldest and grandest of the societies to which infrared researchers belong. In addition to working groups addressing optical technologies, they hold their annual Thermosense meeting in April, which is the major crossroads for commercial infrared detector manufacturers. They also organize yearly conference on FTIR spectrometers, surveillance, machine vision and automated inspection, remote sensing, and scientific research using IR detectors.

**Laser Institute of America**

12424 Research Parkway, Suite 130  
Orlando, FL 32826  
(407) 380-1553  
John Sallik

**National Academy of Engineering**

2101 Constitution Avenue, NW #218  
Washington, DC 20418  
(202) 334-3200

**National Aeronautic Association of the U.S.A.**

1815 N. Fort Myer Drive, #700  
Arlington, VA 22209  
(703) 527-0226

**National Association of Manufacturers**

1331 Pennsylvania Avenue, NW #1500  
Washington, DC 20004  
(202) 637-3000

**National Electrical Contractors Association**

7315 Wisconsin Avenue, #1300-W  
Bethesda, MD 20814  
(301) 657-3110

**National Electrical Manufacturers Association**

2101 L Street, NW, #300  
Washington, DC 20037  
(202) 457-8400

**National Society of Professional Engineers**

1420 King Street  
Alexandria, VA 22314  
(703) 684-2800

**National Tooling and Machining Association**

9300 Livingston Road  
Fort Washington, MD 20744  
(301) 248-6200

**Palisades Institute for Research Services, Inc.**

201 Varick Street, Suite 1140  
New York, N.Y. 10014  
(212) 620-3371

Organizes a yearly Workshop on the Physics and Chemistry of Mercury Cadmium Telluride and Related II-VI Materials. The organizer is Jay Morreale.

**Robotic Industries Association**

900 Victors Way  
P.O. Box 3724  
Ann Arbor, MI 48106  
(313) 994-6088

Incorporates three other associations of interest to infrared firms: Robotic Industries Association, Automated Imaging Association, National Service Robot Association. All are leading associations for manufacturers and integrators of automated inspection and machine guidance machines and systems. Almost all the CCD manufacturers are members, as are the major photonics firms that are interested in the imaging market. Organizes an annual International Robots & Vision Automation Conference in April, and another International Symposium on Industrial Robots, usually in October.

**Society of American Military Engineers**

607 Prince Street  
Alexandria, VA 22314  
(703) 549-3800

**Society for Imaging Science and Technology**

7003 Kilworth Lane  
Springfield, VA 22151  
(703) 642-9090

**Society of Manufacturing Engineers (SME)**

1 SME Drive  
P.O. Box 930  
Dearborn, MI 48121-0930  
(313) 271-2861

The SME, through its publication Manufacturing Engineering Magazine, is very concerned with thermal imagers, because it boosts productivity, saves on maintenance, is a form of non destructive testing, etc. They do not have any working groups or individual societies focused on infrared sensors, but they have groups by industry, so several industries may be interesting to DFI research because they employ IR sensors.

**Society for the Advancement of Materials and Process Engineering**

1161 Park View Drive  
Covina, CA 91724  
(818) 331-0616

Their technical director, Dr. Hammernesh, says that they do not yet cover IRFPAs materials, or IRFPAs as used by process engineers, because they have not yet become prevalent. However, they will be able to put us in touch with engineers and research scientists in specific industries when we target a few industries.

Specialty Steel Industry of the U.S.  
3050 K Street, NW #400  
Washington, DC 20007  
(202) 342-8400

Valve Manufacturers Association of America  
1050 17th Street, NW #701  
Washington, DC 20036  
(202) 331-8105

Appendix F  
Individuals Carrying out Research on Applications of  
Sensitive Infrared Materials Database

**Contact Name:** Margaret Abernathy  
**Position:** Medical Doctor  
**Organization:** Georgetown University Medical Center  
**Component:**  
**Address:** Kober-Cogan 320  
3800 Reservoir Road  
Washington, D.C. 20007  
**Notes:** Active in development of infrared biomedical thermography applications, systems design. Active in American Academy of Thermology.

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**Contact Name:** Warren Achenbaum  
**Position:** President  
**Organization:** Cox & Company, Inc.  
**Component:**  
**Address:** 200 Varick St.  
New York, NY 10014  
**Notes:** Electronic and mechanical engineering, aerodynamics, thermal engineering, mostly for military markets.

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**Contact Name:** Roshan L. Aggarwal  
**Position:** Materials Scientist  
**Organization:** MIT  
**Component:** Electronics Research Lab  
**Address:** Room 13-3030  
77 Massachusetts Avenue  
Cambridge, MA 02139  
**Notes:** Materials scientist on program committee of 1991 and 1992 MCT workshop hosted by Palisades Research Center. Co-authored January 1987 "Infrared Nonlinear Optics"

**Contact Name:** Jean Aitchison  
**Position:** Gen Mgr.  
**Organization:** Photox Optical Systems  
**Component:**  
**Address:** P.O. Box 274  
Headington, Oxford, OX3 0BJ UNITED KINGDOM  
**Notes:** Manufacture of GaAs, germanium, silicon, ZnS, and ZnSe for infrared applications.

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**Contact Name:** Peter Albers  
**Position:** Sales Manager  
**Organization:** Carl Zeiss  
**Component:**  
**Address:** Sondertechnik  
Postfach 1380  
7082 Oberkochen, GERMANY  
**Notes:** Thermal Imaging, Detectors and Sensors, Night Vision for military markets.

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**Contact Name:** John V. Alexander  
**Position:** Public Relations  
**Organization:** AlliedSignal Aerospace  
**Component:**  
**Address:** 2525 W. 190th Street  
Torrance, CA 90504  
**Notes:** Thermal Imaging, detectors and sensors, for military

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**Contact Name:** James Alexiou  
**Position:** Pres  
**Organization:** Irvine Sensors Corp.  
**Component:**  
**Address:** 3001 Redhill Ave Bldg 3  
Costa Mesa, CA 92626  
**Notes:** Applied research in military detection system (infrared sensing). Designs, develops and manufactures proprietary focal planes and focal plane assemblies. Proprietary assemblies include proprietary line arrays and stacked-circuitry mosaic with on-focal-plane signal processing.

**Contact Name:** R.R. Alfano  
**Position:** Research PhD  
**Organization:** Institute for Ultrafast Spectroscopy and Lasers  
**Component:** Photonics Appl. Lab  
**Address:** Department of Electrical Engineering and Physics, Graduate Center of the City Univ of NY, New York, NY 10031  
**Notes:** Active in infrared biomedical thermography as system designer for multi-wavelength, MCT-based systems which overcome emissivity problems.

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**Contact Name:** Charles Alicandro  
**Position:** Commercial Sales  
**Organization:** Inframetrics  
**Component:**  
**Address:** 16 Esquire Road  
North Billerica, MA 01862  
**Notes:** Manufactures IR thermal imaging systems (radiometers) for noncontact temperature measurements. Radiometers feature TV compatible color and b/w imaging with direct temperature measurement capabilities. Image processing systems provide easy detailed analysis of data collected with the thermal camera. A leading supplier for non-destructive evaluation, predictive maintenance IR camera markets.

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**Contact Name:** Lee Allen  
**Position:**  
**Organization:** Allen Infrared Associates  
**Component:**  
**Address:** RR #1, Box 239K  
Coward, SC 29530  
**Notes:** Active in infrared predictive maintenance development regimes and community

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**Contact Name:** Robert Allen  
**Position:** CEO  
**Organization:** American Telephone and Telegraph  
**Component:** AT&T Bell Labs  
**Address:** 600 Mountain Ave.  
Murray Hill, NJ 07974  
**Notes:** Wide range of research in electronics, focusing on emerging technologies including opto-electronics.



**Contact Name:** Robert Allen  
**Position:** CEO  
**Organization:** American Telephone and Telegraph company  
**Component:** AT&T Bell Labs  
**Address:** 600 Mountain Ave.  
Murray Hill, NJ 07974  
**Notes:** Wide range of research in electronics, focusing on emerging technologies including opto-electronics.

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**Contact Name:** Andrew Allen  
**Position:** VP Sales  
**Organization:** EG&G, Inc.  
**Component:** EG&G Judson  
**Address:** 221 Commerce Dr.  
Montgomeryville, PA 18936  
**Notes:** Manufactures infrared detectors and arrays, including Ge, InAs, InSb, MCT, and doped GE. Applications include carbon dioxide laser detection, fiberoptics, spectroscopy, and radiometry.

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**Contact Name:** Kurt Ammer  
**Position:** Dr.  
**Organization:** Ludwig Boltzmann Forschungsstelle fue  
**Component:** Physikalische Diagnostik  
**Address:** Heinrich Collinstr. 30  
A-1140 Wien AUSTRIA  
**Notes:** Active in infrared biomedical thermography system design

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**Contact Name:** Michael Anbar  
**Position:** Dr.  
**Organization:** State University of NY at Buffalo  
**Component:** Dept of Biophysical Sciences  
**Address:** 120 Cary Hall  
Buffalo, NY 14214  
**Notes:** Active in infrared biomedical thermography. Has own biomedical marketing firm to sell infrared technology. Current advisor of the American Institute of Thermology.

**Contact Name:** Michael Anbar  
**Position:** Chairman, Department of Biophysical Sciences  
**Organization:** SUNY Buffalo  
**Component:** School of Medicine  
**Address:** 120 Cary Hall  
Buffalo, NY 14214  
**Notes:** Also has own biomedical ir company called AMARA, Inc. at his home address, 145 Deer Run Road, Williamsville, NY 14221. Chief advisor to American Institute of Thermography. Has worked on biomedical IR for 8 years; grants from NSF and NIH.

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**Contact Name:** Christine Anderson  
**Position:** Ms.  
**Organization:** Cray Research  
**Component:**  
**Address:** 925 First Avenue  
Chippewa Falls, WI 54729-1402  
**Notes:** Active in infrared process control.

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**Contact Name:** Kenneth Anderson  
**Position:** Pres  
**Organization:** Monitek Technologies, Inc.  
**Component:**  
**Address:** 1495 Zephyr Ave.  
Hayward, CA 94544  
**Notes:** Optical and electronic measurement systems to detect particulate matter, oils and color in fluids.

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**Contact Name:** J.R. Anderson  
**Position:**  
**Organization:** University of Maryland  
**Component:**  
**Address:** College Park, MD  
**Notes:** Co-authored 1987 study "Magnetophonon Effect in HgCdTe"  
Co-authored 1987 study "Phase Differences between Quantum Oscillations of the Magnetoresistance and the Hall Effect in HgMnTe and HgCdTe"

**Contact Name:** Martin Andonian  
**Position:** President, Chief Scientist  
**Organization:** Andonian Cryogenics Inc  
**Component:**  
**Address:** 26 Farwell Street  
Newtonville, MA 02160  
**Notes:** Manufactures cryogenic equipment, storage dewars, cryorefrigerators, research cryostats, cold traps, transfer lines, level gauges, and control. Distributes cryogenic liquids, speciality gases, gas handling, and distribution equipment.

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**Contact Name:** N.A. Archer  
**Position:**  
**Organization:** University of Southampton  
**Component:** Engineering Materials  
**Address:** Southampton, SO9 5NH  
UNITED KINGDOM  
**Notes:** Authored "Growth Method, Composition, and Defect Structure Dependence of Mercury Diffusion in CdHgTe" for 1992 MCT Workshop.

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**Contact Name:** Eugene Arthurs  
**Position:** Dir  
**Organization:** Oriel Corp  
**Component:**  
**Address:** 250 Long Beach Blvd., PO Box 872, Stratford, CT 06497  
**Notes:** Optics and detectors for ultraviolet through infrared systems.

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**Contact Name:** Monique Attar  
**Position:** Marketing Administrator  
**Organization:** Loral Fairchild Systems  
**Component:**  
**Address:** 300 Robbins Lane  
Syosset, NY 11791  
**Notes:** Detectors and sensors, e/o systems, night vision, thermal imaging, predominantly for military markets.

**Contact Name:** B Austin  
**Position:** CEO  
**Organization:** Affiliated Manufacturers, Inc. (AMI)  
**Component:**  
**Address:** PO Box 5049  
North Branch, NJ 08876  
**Notes:** Process and manufacturing considerations of the microelectronics manufacturing industry; innovative manufacturing processes; thick film hybrid circuits.

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**Contact Name:** J.C. Austin  
**Position:**  
**Organization:** University of North Carolina at Chapel Hill  
**Component:** Department of Physics and Astronomy  
**Address:** Chapel Hill, NC 27599-3255  
**Notes:** Co-Authored "Observation of Indium-Vacancy and Indium Hydrogen Interactions in (HgCd)Te Using PAC

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**Contact Name:** Ronald Autos  
**Position:** drR&D  
**Organization:** Burleigh Instruments, Inc.  
**Component:**  
**Address:** Burleigh Park  
Fishers, NY 14453  
**Notes:** Product oriented research in lasers, optical equipment, and micropositioning equipment. Sells a leading tunable solid-state IR laser good from 1.45 to 1.75 microns, or 2.3 to 3.45 microns.

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**Contact Name:** K. Awamoto  
**Position:**  
**Organization:** Fujitsu Laboratories, Ltd.  
**Component:** Atsugi Infrared Devices Laboratory  
**Address:** 10-1 Morinosato-Wakamiya  
Atsugi 243-01 JAPAN  
**Notes:** Co-authored for 1992 SPIE Workshop on IRFPAs "Resolution Improvement for HgCdTe IRCCD"

**Contact Name:** Norman Axelrod  
**Position:** Pres  
**Organization:** Norman Axelrod, Associates  
**Component:** Norman N. Axelrod Associates Development Laboratory  
**Address:** 28 W 44th St  
New York, NY 10036  
**Notes:** Planning, development, and fabrication of electro-optical, laser, and machine vision systems for on-line sensing and control, digital and analog information; computer automated optical systems.

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**Contact Name:** J.W. Baars  
**Position:**  
**Organization:** Fraunhofer-Institut für Angewandte Festkörperphysik  
**Component:**  
**Address:** Tullastr. 72  
D-7800 Freiburg, Germany  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials  
"Characterization of Anodic Fluoride Films on HgCdTe"

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**Contact Name:** Marino Babbriotte  
**Position:**  
**Organization:** ESA-ESTEC  
**Component:**  
**Address:** Keplerlaan 1,  
NL-2200 AZ Noordwijk, THE NETHERLANDS  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Comparative Study of SWIR and MWIR Schottky-Barrier Imagers."

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**Contact Name:** Robert Bachner  
**Position:** CEO  
**Organization:** Silicon Sensor Inc  
**Component:**  
**Address:** Hwy 18 E PO Box 137  
Dodgeville, WI 53533  
**Notes:** Manufacture of light sensitive products. Manufactures of SI semiconductor detectors and optocouplers/optoisolators, custom assembly for OEMs, long-line strip detectors, optics hybrid assemblies, etc.

**Contact Name:** R.B. Bailey  
**Position:** Dr.  
**Organization:** Rockwell International Science Center  
**Component:**  
**Address:** 1049 Camino Dos Rios  
Thousand Oaks, CA 91360  
**Notes:** One of top few scientists conducting Rockwell's alternative substrate programs.

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**Contact Name:** George S. Baird  
**Position:**  
**Organization:** Baird Infrared Technology, Inc.  
**Component:**  
**Address:** 110 South Poplar Street #310  
Wilmington, DE 19801-5046  
**Notes:** Active in infrared predictive maintenance as private consultant conducting inspections

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**Contact Name:** Francis Baker  
**Position:** CEO  
**Organization:** Andersen Group  
**Component:**  
**Address:** 1280 Blue Hills Ave.  
Bloomfield, CT 06002  
**Notes:** Research and development in photonics, telecommunications and high tech industries.

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**Contact Name:** Roy Ball  
**Position:** President  
**Organization:** Imago Machine Vision Inc.  
**Component:**  
**Address:** 1354 Wellington Street  
Ottawa, Ontario, CANADA K1Y 3C3  
**Notes:** Security systems and equipment, robotics, e/o systems, infrared systems and equipment, commercial and military.

**Contact Name:** Michel Balle  
**Position:**  
**Organization:** HGH Ingeneric Systemes  
**Component:**  
**Address:** au Parc d'Activities du Moulin de Massy  
3, rue du Saule Trapu  
Massy, 91300 FRANCE  
**Notes:** Active in infrared process control at HGH Ingenerie.

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**Contact Name:** Probal Banerjee  
**Position:** Graduate student  
**Organization:** Auburn University  
**Component:** College of Engineering and Engineering Experiment Station  
**Address:** Materials Engineering  
201 Ross Hall  
Auburn University, AL 36849-5351  
**Notes:** Co-authored 1991 "Weld Quality Control in Gas Tungsten Arc Welding Process" as graduate student for Dr. Chin.

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**Contact Name:** Ed Bangs  
**Position:**  
**Organization:** Infrared Monitoring Systems  
**Component:**  
**Address:** 10 West 35th Street  
Chicago, IL 60616  
**Notes:** Active in development of infrared process control regimes. Integrator and consultant.

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**Contact Name:** George Barringer  
**Position:** Pres  
**Organization:** Groton Technology, Inc.  
**Component:**  
**Address:** 45 Winthrop St.  
Concord, MA 01742  
**Notes:** Applied and product-oriented research in optical interferometry and solid state optical detectors. Application of infrared technologies to scientific spectroscopy.

**Contact Name:** Barry Bassin  
**Position:** President  
**Organization:** Infrared Optical Products, Inc.  
**Component:**  
**Address:** P.O. Box 3033  
South Farmingdale, NY 11735  
**Notes:** Manufacture of CdTe, GaAs, germanium, silicon, ZnS, and ZnSe for infrared applications, both military and commercial.

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**Contact Name:** P.K. Baumann  
**Position:**  
**Organization:** North Carolina State University  
**Component:** Department of Physics  
**Address:** Raleigh, NC 27695-8202  
**Notes:** Authored for 92 MCT workshop "Growth of HgSe and HgCdSe Thin Films by Molecular Beam Epitaxy"

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**Contact Name:** Bill Bauson  
**Position:**  
**Organization:** Delco Electronics  
**Component:**  
**Address:** 700 East Firman Avenue  
Kokomo, IN 46901  
**Notes:** Active in infrared non-destructive evaluation. His firm conducts research in automotive audio equipment and systems, vehicular heat and air conditioner controls, automotive microcomputer-based control systems, integrated circuits, semiconductor devices, thick film hybrid microcircuits, printed circuit boards, automotive electronics, automotive sensors, automotive instruments and displays.

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**Contact Name:** P. Becla  
**Position:**  
**Organization:** MIT  
**Component:**  
**Address:** Dept. of Materials Sci. & Eng.  
Room 13-5099  
Cambridge, MA 02139  
**Notes:** Author of "Growth and Characterization of Device Quality Bulk HgZnTe Crystals" at 1992 MCT Workshop  
For 1991 Workshop "Nonlinear Optical Effects in Rotationally Twinned CdTe and CdMnTe Crystals," and "Long Wavelength HgMnTe Avalanche Photodiodes"



**Contact Name:** Piotr Becla  
**Position:**  
**Organization:** MIT  
**Component:** Electronics Research Lab  
**Address:** 77 Massachussets Avenue  
Cambridge, MA 02139  
**Notes:** Co-authored January 1987 "Infrared Nonlinear Optics"

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**Contact Name:** C.P. Beetz, Jr.  
**Position:**  
**Organization:** Advanced Technology Materials  
**Component:** Semiconductor Products Department  
**Address:** 7 Commerce Drive  
Danbury, CT 06810  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Buffer Layers for Deposition of Superconducting YBaCuO Thin Film on Polycrystalline Diamond"

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**Contact Name:** R.A. Bell  
**Position:** Director of Marketing  
**Organization:** Loral Corporation  
**Component:** Loral Infrared & Imaging Systems, Inc.  
**Address:** 2 Forbes Rd.  
Lexington, MA 02173  
**Notes:**

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**Contact Name:** Brandon Belote  
**Position:** Director Marketing Communications  
**Organization:** ITT Defense and Electronics  
**Component:**  
**Address:** 1000 Wilson Boulevard, Suite 3000  
Arlington, VA 22209  
**Notes:** Night vision, active and passive e/o systems, infrared systems and components for military applications.

**Contact Name:** Valery Belov  
**Position:** President  
**Organization:** Belov Technology Co. Inc.  
**Component:**  
**Address:** 345 Sandford Street  
New Brunswick, NJ 07891  
**Notes:** Manufactures MCT, DTGS, TGS pyroelectric detectors and detector electronic systems, and multi-element arrays. MCT room temperature detectors, and related components.

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**Contact Name:** Alan Bennett  
**Position:** V Pres R&D  
**Organization:** Imo  
**Component:** Varian Industries  
**Address:** 3100 Hansen Way  
Palo Alto, CA 94304  
**Notes:** Producer of a wide variety of military thermal systems. Development of InP- and HgCdTe-based infrared sensors, as well as the use of GaAs materials.

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**Contact Name:** Tucker Bens  
**Position:** Marketing  
**Organization:** Loral Fairchild Imaging Sensors  
**Component:**  
**Address:** 1801 McCarthy Blvd  
Milpitas, CA 95035  
**Notes:**

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**Contact Name:** Tom Benson  
**Position:** CEO  
**Organization:** Innovation Industries, Inc.  
**Component:**  
**Address:** Hwy 64E PO Box K  
Russellville, AR 72801  
**Notes:** Opto-electronics product oriented for patent and manufacture, interest in IR detectors.

**Contact Name:** R.G. Benz  
**Position:**  
**Organization:** Georgia Tech Research Institute  
**Component:** Physical Sciences Laboratory  
**Address:** Room 128 Baker Bldg  
Atlanta, GA 30332  
**Notes:** Authored "CdTe and HgTe Growth Kinetics During Gas Source Molecular Beam Epitaxy" for 1992 MCT Workshop  
For 1991, "Selected-area Epitaxy of CdTe"

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**Contact Name:** M.A. Berding  
**Position:**  
**Organization:** SRI International  
**Component:**  
**Address:** Menlo Park, CA 94025  
**Notes:** Co-Authored "Native Defect Equilibria in HgZnTe and HgCdTe Alloys" for 1992 MCT Workshop.  
For 1991 Workshop, "Defect Equilibrium in HgTe"

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**Contact Name:** Leif Bergstrom  
**Position:** Chairman  
**Organization:** Pharos Inc.  
**Component:** Agema Infrared Systems  
**Address:** 595 Skippack Pike  
Blue Bell, PA 19128  
**Notes:** Pharos is the parent company for Agema in Secaucus.

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**Contact Name:** Enrique Bernal  
**Position:** VP Advanced Materials  
**Organization:** Morton International Advanced Materials  
**Component:**  
**Address:** 185 New Boston Street  
Woburn, MA 01801  
**Notes:** Manufacture of ZnS and ZnSe for infrared applications.

**Contact Name:** R. Besamat  
**Position:** Chief Executive  
**Organization:** Thomson Composants Militaires et Spatiaux  
**Component:**  
**Address:** 50, rue j.-Pierre Thimbaud  
Courbevoie, 92402, FRANCE  
**Notes:** Manufactures semiconductors for the high end professional, military, and space markets. Offers linear and matrix CCDs.

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**Contact Name:** A. Bezinger  
**Position:**  
**Organization:** Kidron Microelectronics Research Center  
**Component:** Department of Electrical Engineering  
**Address:** Technion-Israel Institute of Technology  
Haifa 32000, ISRAEL  
**Notes:** "UV Photon Assisted Control of Interface Charge Between CdTe Substrates and Metal Organic Chemical Vapor Deposition CdTe Epilayers" for 1992 MCT Workshop.

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**Contact Name:** Ishwara B. Bhat  
**Position:**  
**Organization:** Rensselaer Polytechnic Institute  
**Component:** ECSE Department  
**Address:** 110 Eighth Street  
Troy, NY 12180  
**Notes:** Co-authored "Improved CdTe Layers on GaAs and Si Substrates, Grown by Atomic Layer Epitaxy" for 1992 MCT Workshop.  
  
Co-authored for 1991 MCT Workshop "Low Temperature Epitaxy of HgTe, CdTe, and HgCdTe Using Flow Modulation Techniques" and "Reduced Metal-Insulator Semiconductor Tunneling in MOCVD MC(111)Te Films"

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**Contact Name:** Ravi Bhatla  
**Position:**  
**Organization:** Motorola Corporation  
**Component:**  
**Address:** 1303 East Algonquin Road  
Schaumburg, IL 60196  
**Notes:** Designs infrared non-destructive evaluation techniques at Motorola.

**Contact Name:** Jacob Biali  
**Position:** Sales Manager  
**Organization:** ISPRA - Israel Product Research Co. Ltd.  
**Component:**  
**Address:** Galgal Haplada Street, Industrial Zone  
Herzeliya, Israel 052-555464  
**Notes:** Manufacture of germanium, silicon, ZnS, and ZnSe for infrared applications.

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**Contact Name:** Lucien Biberman  
**Position:**  
**Organization:** Institute for Defense Analysis  
**Component:**  
**Address:** 1801 North Beauregard Street  
Alexandria, VA 22311  
**Notes:** Delivered an August 1987 speech delivered to IRIS meeting entitled "Perspective on Focal Plane Arrays" in which he argues that the military establishes hard-to-achieve standards for its IRFPAs, and that costs could be readily reduced without such stringency.

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**Contact Name:** J Bickman  
**Position:** Pres  
**Organization:** Stocker & Yale, Inc  
**Component:**  
**Address:** 133 Brimbal Ave.  
Beverly, MA 01915  
**Notes:** Optical measuring units for manufacturing controls.

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**Contact Name:** R.N. Bicknell-Tassius  
**Position:**  
**Organization:** University of Wurzburg  
**Component:**  
**Address:** GERMANY  
**Notes:** Authored for SPIE 1991 meeting on Growth of IR materials "Growth of CdTe-CdMnTe Heterostructures by MBE"

**Contact Name:** Rollo Black  
**Position:** Business Development  
**Organization:** Eastman Kodak Co.  
**Component:** Government Systems Div.  
**Address:** 1447 St. Paul Street  
Rochester, NY 14653  
**Notes:** IR Detectors work, mostly PtSi.

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**Contact Name:** Edward Blanchet  
**Position:** President  
**Organization:** Santa Barbara Infrared Inc.  
**Component:**  
**Address:** 312A North Nopal Street  
Santa Barbara, CA 93101  
**Notes:** Manufactures commercial and military IR test equipment. Products include differential blackbody sources, collimators, IR target projects, FLIR test equipment. Also provides applications engineering and custom design engineering for commercial, custom and militarized IR test systems for laboratory and field use.

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**Contact Name:** John Blocha  
**Position:** President  
**Organization:** Pilkington Visioncare  
**Component:** Coburn Optical Industries  
**Address:** Suite 200, 4606 S Garnett  
Tulsa, OK 74146  
**Notes:** Development of infrared products for military and commercial applications.

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**Contact Name:** Betty Blodgett  
**Position:** Marketing  
**Organization:** Datametrics Corp.  
**Component:**  
**Address:** 8986 Comanche Avenue  
Chatsworth, CA 91311  
**Notes:** Thermal Imaging for military applications.

**Contact Name:** Glenn D. Boreman  
**Position:**  
**Organization:** University of Central Florida  
**Component:** Electrical Engineering Department and Center for Research in Electro-Optics and Lasers  
**Address:** 12424 Research Parkway, Suite 400  
Orlando, FL 32828  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Use of Narrowband Laser Speckle for MTF Characterization of CCDs"

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**Contact Name:** John D. Bossler  
**Position:**  
**Organization:** Ohio State University  
**Component:** Center For Mapping  
**Address:** 1216 Kinnear Road  
Columbus, OH 43212  
**Notes:** Active in infrared remote sensing for scientific research.

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**Contact Name:** K.A. Bowers  
**Position:**  
**Organization:** North Carolina State University  
**Component:** Department of Physics  
**Address:** Raleigh, NC 27695-8202  
**Notes:** Co-Authored for 1991 MCT Workshop "Properties of CdZnTe Crystals Grown by a High Pressure Bridgman Method"

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**Contact Name:** Kim Boyer  
**Position:**  
**Organization:** Ohio State Univeristy  
**Component:**  
**Address:** 469 Dreese Lab  
2015 Knil Avenue  
Columbus, OH 43210-1210  
**Notes:** Active in process control community as leader of SPIE's workshop on machine vision. Has good overview of machine vision markets.

**Contact Name:** G. Stan Boyington  
**Position:** Director Business Development  
**Organization:** SPAR Aerospace, Ltd.  
**Component:** Advanced Technology Systems Group  
**Address:** 9445 Airport Road  
Brampton, Ontario, CANADA L6S 4J3  
**Notes:** Infrared systems and equipment, c/o systems, thermal imaging for military applications.

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**Contact Name:** W.R. Bradbury  
**Position:** Mktg. Dir.  
**Organization:** Specac Ltd.  
**Component:**  
**Address:** River House, Lagoon Rd.  
St. Mary Cray, Orpington, Kent BR5 3QX  
UNITED KINGDOM  
**Notes:** Manufacture of germanium, silicon, ZnS, and ZnSe for infrared applications.

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**Contact Name:** Marvin L. Braman  
**Position:** Director of Public Relations  
**Organization:** Lockheed Sanders, Inc.  
**Component:**  
**Address:** NHQ-1-735  
68 Spit Brook Road  
Nashua, NH 03061  
**Notes:** Infrared systems and equipment, passive and active c/o devices for military markets.

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**Contact Name:** Maruice J. Brau  
**Position:**  
**Organization:** Colorado Research Lab  
**Component:**  
**Address:** Walsenburg, CO  
**Notes:** Authored January 1991 report "Ultra-high-purity Starting Materials for Infrared Detector Crystal Growth"  
and January 1991 "Traveling Heater Method Growth of Bulk Compound Semiconductor Alloy Crystals"



**Contact Name:** Richard A. Bredthauer  
**Position:**  
**Organization:** MIT  
**Component:** Lexington Lincoln Lab  
**Address:** 244 Wood Street  
Lexington, MA 02173-9108  
**Notes:** Co-authored August 1989 study entitled "128 X 128 Element IrSi Schottky-Barrier Focal Plane Arrays for LWIR Imaging"

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**Contact Name:** D. Brink  
**Position:**  
**Organization:** Fraunhofer-Institut für Angewandte Festkörperphysik  
**Component:**  
**Address:** Tullastr. 72  
D-7800 Freiburg, Germany  
**Notes:** AAuthor of "Characterization of MCT Heterostructures by Thermoelectric Measurements"

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**Contact Name:** George Brooks  
**Position:** Group Vice President  
**Organization:** Rockwell International Corp.  
**Component:** Government Business Division  
**Address:** 1201 S Second St.  
Milwaukee, WI 53204  
**Notes:** Passive electronic components, including IR detectors.

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**Contact Name:** Mark Broughton  
**Position:** Head of public Relations  
**Organization:** Marconi Radar and Control Systems, Ltd.  
**Component:**  
**Address:** P.O. Box 133  
Chobham Road, Frimley  
Camberley, Surrey, UK GU16 5PE  
**Notes:** Thermal Imaging, detectors and sensors, night vision for military markets.

**Contact Name:** Lloyd Brunkhorst  
**Position:** VPeng  
**Organization:** Brown Group, Inc.  
**Component:** Research and Development Laboratory  
**Address:** 8400 Maryland Ave.  
Saint Louis, MO 63166  
**Notes:** Basic research for new manufacturing processes, including IR detectors.

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**Contact Name:** Robert Bruno  
**Position:** VP Marketing  
**Organization:** Inframetrics  
**Component:**  
**Address:** 16 Esquire Road  
North Billerica, MA 01862  
**Notes:**

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**Contact Name:** Leonard Brzozwski  
**Position:** Pres  
**Organization:** Robotron Corp.  
**Component:**  
**Address:** 21300 W Eight Mile Rd.  
PO Box 5090, Southfield, MI 48086  
**Notes:** Ion processing and other non-traditional heat treating processes, welding of  
ferrous and non ferrous metals

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**Contact Name:** L.O. Bubulac  
**Position:**  
**Organization:** Fraunhofer-Institut fur Angewandte Festkorperphysik  
**Component:**  
**Address:** Tullastr. 72  
D-7800 Freiburg, Germany  
**Notes:** AUthor of "Characterization of MCT Heterostructures by Thermoelectric  
Measurements"

**Contact Name:** Hans Bucher  
**Position:** Pres  
**Organization:** Xedar Corp.  
**Component:**  
**Address:** 2500 Central Ave.,  
Boulder, CO 80301  
**Notes:** Electro-optical research applied to field of infrared and thermal imagery.

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**Contact Name:** Hans Bucher  
**Position:**  
**Organization:** Xedar Corp.  
**Component:**  
**Address:** 2500 Central Avenue  
Boulder, CO 80301  
**Notes:** infrared non-destructive evaluation

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**Contact Name:** H. Budzier  
**Position:**  
**Organization:** Dresden University of Technology  
**Component:** Institut fur Festkorperelektronik  
**Address:** Dresden, FEDERAL REPUBLIC OF GERMANY  
**Notes:** Co-authored for 1992 SPIE IRFPA meeting "Pyroelectric IR Single-Element Detectors and Arrays Based on LiNbO3 and LiTaO3"  
  
Co-authored for 1991 SPIE meeting on Growth of IR Materials "Pyroelectric Linear Array IR Detectors with CCD Multiplexer"

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**Contact Name:** J. Buic  
**Position:** Marketing Manager  
**Organization:** Honeywell, Inc.  
**Component:** Solid State Sensors Group  
**Address:** 830 E. Arapaho Road  
Richardson, TX 75081  
**Notes:** Manufactures IR optoelectronic components and assemblies, fiberoptic components, and modules.

**Contact Name:** Richard Buonauto  
**Position:**  
**Organization:** Alpha Omega Instruments Corp  
**Component:**  
**Address:** 253 Mansfield Drive, P.O. Box DE  
Norton, MA 02766  
**Notes:** Has developed an approach to manufacturing a low cost, two-dimensional array using lead selenide or other resistive type detectors, with a targeted manufacturing cost of under \$500 in quantities.

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**Contact Name:** Kelly Burke  
**Position:** Operations Manager  
**Organization:** Crystal Specialties International  
**Component:**  
**Address:** 2853 Janitall Road  
Colorado Springs, CO 80906  
**Notes:** Production of GaAs and germanium for infrared applications for both military and commercial markets.

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**Contact Name:** Richard Burkel  
**Position:** Manager, Inspection Automation  
**Organization:** General Electric Co.  
**Component:** General Electric Aircraft Engines  
**Address:** 1 Neumann Way, P.O. Box 156301  
Cincinnati, OH 45215-6301  
**Notes:** Designed GEAE's thermographic inspection equipment for non-destructive evaluation of jet engine parts, originally from Air Force funding

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**Contact Name:** Douglas Burlcigh  
**Position:**  
**Organization:** General Dynamics  
**Component:** Space Systems Division  
**Address:** 2945 Arcola Avenue  
San Diego, CA 92117  
**Notes:** Active in infrared remote sensing, predictive maintenance, non-destructive evaluation, for both military and commercial applications.

**Contact Name:** William J. Burns  
**Position:** President  
**Organization:** Emcore Corp.  
**Component:**  
**Address:** 35 Elizabeth Avenue  
Somerset, NJ 08873  
**Notes:** Material production of GaAs, CdTe, silicon, ZnS, and ZnSe for infrared applications, both military and commercial.

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**Contact Name:** Bernard Burns  
**Position:** Director of Sales  
**Organization:** II-VI Inc.  
**Component:**  
**Address:** 375 Saxonburg Blvd  
Saxonburg, PA 16056  
**Notes:**

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**Contact Name:** Dr Wayne Burwell  
**Position:** Dir  
**Organization:** United Technologies Corp.  
**Component:** United Technologies Research Center  
**Address:** Silver Ln.  
East Hartford, CT 06108  
**Notes:** Development of advanced infrared electronic systems.

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**Contact Name:** H. Buskes  
**Position:**  
**Organization:** BHP Research  
**Component:** Melbourne Laboratories  
**Address:** P.O. Box 264  
Clayton, 3168, AUSTRALIA  
**Notes:** Co-authored for 1992 MCT Workshop "In-Situ Ellipsometric Measurements of the MBE Growth of CdTe/HgTe and CdTe/ZnTe Superlattices."

**Contact Name:** Walter Butler  
**Position:** Gmgr  
**Organization:** General Electric Company  
**Component:** Electronics Laboratory  
**Address:** Bldg 3, Electronic Park  
Syracuse, NY 13221  
**Notes:** Development of infrared arrays with particular focus on HgCdTe and InSb-based systems. Programs include theIRST for the F-14D and AADEOS.

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**Contact Name:** W.A. Cabanski  
**Position:**  
**Organization:** University of Erlangen  
**Component:**  
**Address:** Erlangen, GERMANY  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Electronic and Optical Properties of Silicide/ Silicon IR Detectprs"

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**Contact Name:** C. Caillas  
**Position:**  
**Organization:** Carnegie-Mellon University  
**Component:** Robotics Institute  
**Address:** 5000 Forbes Avenue  
Pittsburgh, PA 15213  
**Notes:** Authored an April 1990 study, 100 pages, on "Thermal Imaging for Robotic Applications in Outdoor Scenes" available from DTIC. Artificial intelligence automation inspection his speciality.

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**Contact Name:** Duncan Campbell  
**Position:** Corp. V.P.  
**Organization:** BDM Federal, Inc.  
**Component:**  
**Address:** 1501 BDM Way  
McLean, VA 22102-3204  
**Notes:** Thermal Imaging, imaging software, for military.

**Contact Name:** Tony Canning  
**Position:**  
**Organization:** Atlantic Research Canada, Inc.  
**Component:**  
**Address:** 1900 City Park Drive, Suite 400  
Gloucester, Ontario CANADA K1J 1A3  
**Notes:** Thermal Imaging, predominantly for military applications

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**Contact Name:** R.W. Capps  
**Position:**  
**Organization:** California Institute of Technology  
**Component:**  
**Address:** 1201 East California Boulevard  
Pasadena, CA 91125  
**Notes:** Co-authored for 1990 IEEE Meeting on Advanced IR Detectors "Space Science Applications of Infrared Detector Technology: A Review"

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**Contact Name:** Pamela E. Carey  
**Position:** Ms.  
**Organization:** BDM Inc.  
**Component:**  
**Address:** 4001 North Fairfax Drive  
Arlington, VA 22203  
**Notes:** Authored for 1992 SPIE workshop on IRFPAs "Modeling the Cost and Producibility Impacts of IRFPA Operability." Expert on cost-operability tradeoffs with focal plane arrays.

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**Contact Name:** G.P. Carey  
**Position:**  
**Organization:** Fraunhofer-Institut für Angewandte Festkörperphysik  
**Component:**  
**Address:** Tullastrasse 72  
D-7800 Freiburg, GERMANY  
**Notes:** Authored "XPD Investigation of Substrate Crystallinity at HgCdTe (111B) and CdTe(111)B Surfaces Upon Ag and Al Overlayer Formation."

**Contact Name:** Jim Carey  
**Position:** Marketing Director  
**Organization:** Loral Electro-Optical Systems  
**Component:**  
**Address:** 300 North Halstead Street  
Pasadena, CA 91107  
**Notes:** Infrared systems and equipment, c/o systems predominantly for military applications.

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**Contact Name:** Frederick M. Carlson  
**Position:**  
**Organization:** Clarkson University  
**Component:**  
**Address:** Potsdam, NY 13699  
**Notes:** Attended 1992 MCT conference. Works on MCT related semiconductor research.

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**Contact Name:** DR James Carnesca  
**Position:** Pres  
**Organization:** SRI International  
**Component:** David Sarnoff Research Center  
**Address:** 201 Washington Rd  
Princeton, NJ 08543-5300  
**Notes:** Manufacturing materials, consumer electronics and information sciences, and solid state systems.

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**Contact Name:** J Carpenter  
**Position:** Pres  
**Organization:** Visidyne Inc  
**Component:**  
**Address:** 10 Corporate Pl.,  
Burlington, MA 01803  
**Notes:** Development of electro-optical instrumentation.



**Contact Name:** Melvin J. Carr  
**Position:** President  
**Organization:** Galtech Semiconductor Materials Corp.  
**Component:**  
**Address:** 265 North State Street  
Mt. Pleasant, UT 84647  
**Notes:** Manufacture of CdTe infrared materials, germanium, wafers and ingots,  
monocrystalline and polycrystallins. Polishing and slicing series for CdTe and  
CdZnTe.

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**Contact Name:** John C. Carson  
**Position:** Senior Vice President  
**Organization:** Irvine Sensors Corp.  
**Component:**  
**Address:** 3001 Redhill Ave Bldg 3  
Costa Mesa, CA 92626  
**Notes:** Applied research in military detection system (infrared sensing).

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**Contact Name:** Kent Carson  
**Position:** Director, Infrared Materials Lab  
**Organization:** Texas Instruments  
**Component:**  
**Address:** P.O. Box 655936, MS 150  
Dallas, TX 75265  
**Notes:**

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**Contact Name:** Kent R. Carson  
**Position:** Director  
**Organization:** Texas Instruments  
**Component:** Infrared Materials Laboratory  
**Address:** P.O. Box 655936, MS 150  
Dallas, TX 75265  
**Notes:**

**Contact Name:** JoElaine Cary  
**Position:** CEO  
**Organization:** International Advanced Materials Inc.  
**Component:**  
**Address:** 2 North Circle Avenue  
Spring Valley, NY 10977  
**Notes:** Manufacture of CdTe, GaAs, germanium, silicon, ZnS, and ZnSe materials for infrared systems, military and commercial.

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**Contact Name:** Richard Caserio  
**Position:** Sales Manager  
**Organization:** ITI Electro-Optics Corp.  
**Component:**  
**Address:** 11500 W Olympic Blvd  
Los Angeles, CA 90064  
**Notes:** Manufacture of CdTe, GaAs, germanium, ZnS, and ZnSe for infrared technologies.

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**Contact Name:** J-P. Chamonal  
**Position:**  
**Organization:** LETI (CEA- Technologies Avancees)  
**Component:** DOPT - CEN/G - 85 X-  
**Address:** 38041 Grenoble Cedex FRANCE  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Recent Developments on 12.5 um Infrared Detection Buttable Linear Arrays."

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**Contact Name:** Tin-Fung Chang  
**Position:**  
**Organization:** Chung-Shan Institute of Science and Technology  
**Component:**  
**Address:** Lung-Tan, Taiwan, REPUBLIC OF CHINA  
**Notes:** Co-authored for 1992 SPIE IRFPA meeting "Electrolyte Electroreflectance Spectroscopies for the Ion-Implanted HgCdTe with Thermal Annealing"

**Contact Name:** C. Chang  
**Position:**  
**Organization:** University of Maryland  
**Component:**  
**Address:** Baltimore, MD  
**Notes:** Co-authored for 1992 SPIE meeting on Infrared Imaging Systems "Single-frame Multispectral Thermal Imagery"

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**Contact Name:** K.T. Chang  
**Position:**  
**Organization:** University of Southern California  
**Component:** Department of Materials Science and Engineering  
**Address:** Los Angeles, CA 90089-0241  
**Notes:** Co-authored for 1991 MCT Workshop "Ordered Phase in (HgCd)Te Grown by LPE on CdTe (111)B Substrate"

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**Contact Name:** Shi-Chen Chao  
**Position:**  
**Organization:** National Taiwan University  
**Component:** Department of Electrical Engineering  
**Address:** Taipei, Taiwan, REPUBLIC OF CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Electrolyte Electroreflectance Spectroscopies for the Ion-Implanted HgCdTe with Thermal Annealing"

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**Contact Name:** Tuvia Charmey  
**Position:** Advertising Manager  
**Organization:** Elop-Electro Optics Industries  
**Component:**  
**Address:** P.O. Box 1165  
Rehovot, Israel 76110  
**Notes:** Infrared systems and equipment, thermal imaging, detectors and sensors, night vision for military applications.

**Contact Name:** J.P. Chatard  
**Position:** Dr.  
**Organization:** Sofradir  
**Component:**  
**Address:** 43/47 rue Camille Pelletan  
92290 Chatenay-Malabry  
FRANCE  
**Notes:** Head research scientist working on SOFRADIR's process for reduction of IRFPA costs, presented paper on analysis criteria selection for IRFPA detector production at 1992 SPIE Orlando meeting.

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**Contact Name:** An-Ban Chen  
**Position:**  
**Organization:** Auburn University  
**Component:** Physics Department  
**Address:** Auburn, AL 36849  
**Notes:** Author of "Comparison of InTiSb and HgCdTe as Infrared Material." at 1992 MCT Workshop. Has done MCT producibility-related research.

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**Contact Name:** C.K. Chen  
**Position:**  
**Organization:** MIT  
**Component:** Lexington Lincoln Lab  
**Address:** 244 Wood Street  
Lexington, MA 02173-9108  
**Notes:** Co-authored April 1990 study entitled "PtSi Schottky-Barrier Focal Plane Arrays for Multispectral Imaging in Ultraviolet, Visible, and Infrared Spectral Bands"

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**Contact Name:** Y.P. Chen  
**Position:**  
**Organization:** University of Illinois at Chicago  
**Component:** Microphysics Laboratory, Physics Department  
**Address:** P.O. Box 4348  
Chicago, IL 60680  
**Notes:** Authored "Structure of CdTe(111)B grown by MBE on Misoriented Si(001)" for 1992 MCT Workshop.  
For 1991 Workshop, "Current Status of Direct Growth of CdTe and HgCdTe on Silicon by MBE"

**Contact Name:** Arthur Chester  
**Position:** VP  
**Organization:** General Motors Corporation  
**Component:** Hughes Aircraft Co., Research Laboratories  
**Address:** 3011 Malibu Canyon Rd  
Malibu, CA 90265  
**Notes:** Production of GaAs and InP integrated circuits; infrared sensors, especially monolithic focal plane arrays, for military markets.

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**Contact Name:** Arthur N. Chester  
**Position:** Vice President and Director  
**Organization:** Hughes Research Laboratories  
**Component:**  
**Address:** 3011 Malibu Canyon Road  
Malibu, CA 90265  
**Notes:** The research laboratories conduct long range applied scientific research in physics, chemistry, electronics, and information sciences.

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**Contact Name:** A.C. Childs  
**Position:**  
**Organization:** Rockwell International Corporation  
**Component:** Electro-Optics Center  
**Address:** 3370 Miraloma Avenue  
Anaheim, CA 92803  
**Notes:** Production of MCT-based arrays on alternative substrates under company funding and PACE I and PACE II contracts from military.

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**Contact Name:** B.A. Chin  
**Position:**  
**Organization:** Auburn University  
**Component:**  
**Address:**  
**Notes:** Co-authored 1991 "Weld Quality Control in Gas Tungsten Arc Welding Process"

**Contact Name:** Bryan Chin  
**Position:**  
**Organization:** Auburn University  
**Component:**  
**Address:**  
**Notes:** Co-authored 1984 "Automatic Welding: Infrared Sensors for Process Control Computer Based Factory Automation"

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**Contact Name:** Brian Chin  
**Position:** Professor  
**Organization:** Auburn University  
**Component:** College of Engineering and Engineering Experiment Station  
**Address:** 201 Ross Hall  
Auburn, AL 36849-5351  
**Notes:** Designs automated welding systems using IR detectors for machine vision.

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**Contact Name:** Laurel Chivari  
**Position:** Manager, Public Relations  
**Organization:** Northrop Corp.  
**Component:** Electronics Systems Division  
**Address:** 600 Hicks Road  
Rolling Meadows, IL 60008-1098  
**Notes:** Infrared systems and equipment for military applications.

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**Contact Name:** James Chladek  
**Position:** Vice President  
**Organization:** CIC International, Ltd.  
**Component:**  
**Address:** 38-01 23rd Avenue  
Astoria, NY 11105  
**Notes:** Detectors and Sensors, infrared systems and equipment, night vision equipment for military.

**Contact Name:** J. Choi  
**Position:**  
**Organization:** University of Maryland  
**Component:**  
**Address:** College Park, MD  
**Notes:** Co-authored 1987 study "Magnetophonon Effect in HgCdTe"

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**Contact Name:** Deepak Chopra  
**Position:** President  
**Organization:** UDT Sensors Inc  
**Component:**  
**Address:** 12525 Chadron Ave.  
Hawthorne, CA 90250  
**Notes:** Development of light-based sensors.

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**Contact Name:** Deepak Chopra  
**Position:** Pres  
**Organization:** UDT Sensors Inc  
**Component:**  
**Address:** 12525 Chadron Ave.  
Hawthorne, CA 90250  
**Notes:** Development of light-based sensors.

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**Contact Name:** J.A. Christensen  
**Position:** Marketing Director  
**Organization:** Hughes Aircraft Co.  
**Component:** Electron Dynamics Division  
**Address:** 3100 W. Lomita  
Torrance, CA 90509-2999  
**Notes:**

**Contact Name:** Joseph Christenson  
**Position:** Pres  
**Organization:** Pattern Processing Technologies  
**Component:**  
**Address:** Suite 170, 10025 Valley View Rd.  
Eden Prairie, MN 55344  
**Notes:** Product oriented machine vision systems, some IR experience.

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**Contact Name:** Bernard Christophe  
**Position:**  
**Organization:** SAT  
**Component:**  
**Address:** 41, rue Cantagrel  
F-75361 Paris Cedex 13 FRANCE  
**Notes:** Along with Thomson CSF, places HgCdTe-based sensors on a variety of military products, including the Rafale fighter. Also produces own InSb-based IRFPAs for use in missile guidance.

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**Contact Name:** J.H. Chu  
**Position:**  
**Organization:** Shanghai Institute of Technical Physics  
**Component:** National Laboratory for INfrared Physics  
**Address:** Academia Sinica  
Shanghai 200083  
CHINA  
**Notes:** Co-authored for 1991 MCT Workshop "Influence of Resonant Defect States on Subband Structures in HgCdTe"

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**Contact Name:** John Cicotta  
**Position:** Marketing Communications Manager  
**Organization:** Harris RF Communications  
**Component:**  
**Address:** 1680 University Avenue  
Rochester, NY 14610  
**Notes:** Thermal imaging, digital imaging systems, imaging software for military.



**Contact Name:** Ray P. Clark  
**Position:** Dr.  
**Organization:** King's College  
**Component:** Thermal Biology Research Unit  
**Address:** Campden Hill Road, Kensington  
London, W8 7AH, UNITED KINGDOM  
**Notes:** Active in infrared biomedical thermography as system designer and leading researcher, developing new applications. Widely published.

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**Contact Name:** Ray P. Clark  
**Position:** Dr.  
**Organization:** King's College London, University of London  
**Component:** Thermal Biology Research Unit  
**Address:** Campden Hill Road  
Kensington, Longon W8 7AH UNITED KINGDOM  
**Notes:** President of European Academy of Thermology 1993-1994.

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**Contact Name:** David Clist  
**Position:** Business Development Manager  
**Organization:** Marine-Air Systems  
**Component:**  
**Address:** 24 Bridge Street  
P.O. Box 30-248  
Lower Hutt, NEW ZEALAND  
**Notes:** E/o systems, detectors & sensors, infrared systems & equipment, thermal imaging for military markets.

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**Contact Name:** Robert L. Cockrell  
**Position:** Director, Business Development  
**Organization:** Amherst Systems, Inc.  
**Component:**  
**Address:** 30 Wilson Road  
Buffalo, NY 14221  
**Notes:** Passive and Active electro-optical systems, infrared systems & equipment mainly for military.

**Contact Name:** C.A. Cockrum  
**Position:**  
**Organization:** SBRC  
**Component:**  
**Address:** 75 Coromar Drive  
Goleta, CA 93117  
**Notes:** Predominantly MCT-based IR systems, focal planes arrays, and components, including dewar assemblies, for military use.  
Research scientist involved in SBRC's MCT IRFPA projects; substrate work too.

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**Contact Name:** Antonio Colantonio  
**Position:**  
**Organization:** Technology, Architectural, and Engineering Services  
**Component:** Public Works Canada  
**Address:** Riverside Drive  
Ottawa, Ontario, CANADA K1A 0M2  
**Notes:** infrared non-destructive evaluation

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**Contact Name:** AD Cole  
**Position:** Pres  
**Organization:** Adcole Corporation  
**Component:**  
**Address:** 669 forest St.  
Marlborough, MA 01752  
**Notes:** Research on sun sensing systems, scientific instruments for rockets and satellites, linear and radial electro-optical measuring techniques, computer controlled cylindrical coordinate gauging equipment.

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**Contact Name:** Michael Coleman  
**Position:** Direng  
**Organization:** Advanced Design Corporation  
**Component:**  
**Address:** 8560 Cinderbed Rd  
Newington, VA 22122  
**Notes:** Product oriented electro-optics; night vision devices both image intensification and thermal imaging. Military.

**Contact Name:** John Coleman  
**Position:** CEO  
**Organization:** Plasma Physics Corp.  
**Component:**  
**Address:** PO Box 548  
Locust Valley, NY 11560  
**Notes:** Development and manufacture of photoreceptor drums, solar cells and imaging, polymer laminating, and laser isotope separation.

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**Contact Name:** D.A. Collins  
**Position:** Dr.  
**Organization:** California Institute of Technology  
**Component:**  
**Address:** 1201 East California Boulevard  
Pasadena, CA 91125  
**Notes:** Reported at the DARPA Program Review on Infrared Focal Plane Array Technology in December, 1992, on "InAs/GaInSb Superlattices: Growth Involving Anion Switching"

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**Contact Name:** Luigi Colombo  
**Position:**  
**Organization:** Texas Instruments  
**Component:** Central Research Laboratories  
**Address:** P.O. Box 655936, MS 154  
Dallas, TX 75265  
**Notes:**

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**Contact Name:** R. Coltart  
**Position:** Press Officer  
**Organization:** GEC Marconi Dynamics, Ltd.  
**Component:**  
**Address:** The Grove  
Warren Lane  
Stanmore, Middlesex, UK HA7 4LY  
**Notes:** Infrared systems and equipment, MMW radar, etc. for military applications

**Contact Name:** Ervin Colton  
**Position:** Chief Executive  
**Organization:** Cerac Inc.  
**Component:**  
**Address:** P.O. Box 1178  
Milwaukee, WI 53201  
**Notes:** Manufacturer of infrared materials, as well as specialty inorganic chemicals, evaporation materials, and sputtering targets in both R&D and bulk quantities. Specializes in materials of well defined purity and size including oxides, fluorides, silicides, borides, nitrides, carbides, sulfides, and intermetallic powders.

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**Contact Name:** Thomas Connolly  
**Position:**  
**Organization:** Oriel Corp.  
**Component:**  
**Address:** 250 Long Beach Blvd  
Stratford, CT 06497  
**Notes:** Manufacture of GaAs, germanium, silicon, and ZnSe for infrared applications, for both military and commercial markets.

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**Contact Name:** Peter C. Connolly  
**Position:** Business Development Manager  
**Organization:** Photronics Corp.  
**Component:**  
**Address:** 270 Motor Parkway  
P.O. Box 11368  
Hauppauge, NY 11788  
**Notes:** E/o systems, infrared systems and equipment, night vision for military applications.

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**Contact Name:** Augusto Conte-Matos  
**Position:**  
**Organization:** Georgia Tech Research Institute  
**Component:** Physical Sciences Laboratory  
**Address:** Room 128 Baker Bldg  
Atlanta, GA 30332  
**Notes:** Co-authored for 1991 MCT Workshop "Gas Source Iodine Doping and Characterization of MBE Grown CdTe"

**Contact Name:** J.W. Cook  
**Position:**  
**Organization:** North Carolina State University  
**Component:** Department of Physics  
**Address:** Raleigh, NC 27695-8202  
**Notes:** Co-AUthored "Integrated Heterostructure Devices Based on II-VI Compound Semiconductors" for 1992 MCT Workshop  
Co-Authored for 1991 MCT Workshop "Quantum Hall Effect adn Setback Modulation Doping HgTe-CdTe Heterostructures"

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**Contact Name:** J.W. Cook  
**Position:**  
**Organization:** North Carolina State University  
**Component:** Department of Physics  
**Address:** Raleigh, NC 27695-8202  
**Notes:** Authored for 92 MCT workshop "Growth of HgSe and HgCdSe Thin Films by Molecular Beam Epitaxy"

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**Contact Name:** Diane Cook  
**Position:**  
**Organization:** Univeristy of Texas at Arlington  
**Component:** Dept of Computer Science Engineering  
**Address:** P.O. Box 19015  
Arlington, TX 76019-0015  
**Notes:** active in infrared process control

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**Contact Name:** R.P. Cooper  
**Position:**  
**Organization:** Ford Motor Co.  
**Component:** Scientific Research Laboratory  
**Address:** P.O. Box 2053  
Dearborn, MI 48121  
**Notes:** Interested in designing IR systems to **nondestructively** test cars for paint delamination and rust

**Contact Name:** W. Covington  
**Position:**  
**Organization:** Sam Houston State University  
**Component:** Department of Physics  
**Address:** Huntsville, TX 77341  
**Notes:** Co-authored "Properties of InAs/(Ga,In)Sb Strained Layer Superlattices Grown on the (111) Orientations" for 1992 MCT Workshop

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**Contact Name:** David H. Cowling  
**Position:**  
**Organization:** Louisiana Tech University  
**Component:** College of Engineering  
**Address:** Tech Station, P.O. Box 10348  
Ruston, LA 70803-0301  
**Notes:** Co-authored 1990 "A Simplified Vision System With Robotic Assembly and Manufacturing Applications"

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**Contact Name:** Edward Cox  
**Position:**  
**Organization:** Digital Equipment Corp  
**Component:**  
**Address:** Mail Stop MLO5-4/E22  
Maynard, MA 01754  
**Notes:** Has conducted research on the use of infrared non-destructive evaluation of integrated circuit boards

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**Contact Name:** Robert Cox  
**Position:** President  
**Organization:** Emerson Electric Co  
**Component:** Rosemount Inc.  
**Address:** 12001 technology Dr.  
Eden Prairie, MN 55344  
**Notes:** Applied research on sensors and instruments for measurements of temperature, flow level, pressure, and other industrial applications. Uses IR detectors for various spectrometers, FTIR, gas analysis and detection applications.

**Contact Name:** Steve Cox  
**Position:** Pres  
**Organization:** Lasermike, Inc.  
**Component:**  
**Address:** 6060 Executive Blvd  
Dayton, OH 45424  
**Notes:** Development of intelligent sensors; although work is more involved in software and image processing, some work with IR sensors.

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**Contact Name:** Elliot Cramer  
**Position:**  
**Organization:** NASA  
**Component:** Langley Research Center  
**Address:** MS 231  
Hampton, VA 23665  
**Notes:** Infrared non-destructive evaluation, mainly advanced composites, esp. aging aircraft skins.

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**Contact Name:** Dr Clara Craver  
**Position:** COO  
**Organization:** Craver & Craver Inc  
**Component:**  
**Address:** 761 W Kirkham Ave.  
Saint Louis, MO 63122  
**Notes:** Computer-assisted database searches in infrared spectroscopy; reference spectra for IR.

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**Contact Name:** B. Scott Crews  
**Position:**  
**Organization:** NASA  
**Component:** Langley Research Center  
**Address:** Analytical Services and Materials, Inc.  
MS 231  
Hampton, VA 23655  
**Notes:** Infrared non-destructive evaluation, mainly of aging aircraft skins.

**Contact Name:** Paul D. Croissant  
**Position:** Dr.  
**Organization:**  
**Component:**  
**Address:** 1711 Woodward Avenue  
Bloomfield, MI 48103  
**Notes:** Doctor in private practice active in infrared biomedical thermography associations

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**Contact Name:** D.J. Crowther  
**Position:**  
**Organization:** Wayne State University  
**Component:** Dept of Physics and Inst for Manufacturing Research  
**Address:** Detroit, MI 48202  
**Notes:** infrared non-destructive evaluation

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**Contact Name:** James E. Culley  
**Position:**  
**Organization:** Picker International, Ltd.  
**Component:** Engineering Dept  
**Address:** P.O. Box 2, East Lane  
Wembley, HA9 7PR, UNITED KINGDOM  
**Notes:** Active in infrared biomedical thermography, has written extensively about the broad applications for IR thermography.

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**Contact Name:** Darrell Curtis  
**Position:** Director Business Development  
**Organization:** DBA Systems, Inc.  
**Component:**  
**Address:** P. O. Box 550  
Melbourne, FL 32902  
**Notes:** Thermal Imaging, infrared systems and equipment for military applications



**Contact Name:** Richard Curtiss  
**Position:** Gmgr  
**Organization:** Raytheon Comp.  
**Component:** Electromagnetic Systems Division  
**Address:** 6380 Hollister Ave.  
Goleta, CA 93117  
**Notes:** Infrared countermeasures and high frequency microwave and antennas.

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**Contact Name:** Arthur Cussen  
**Position:** Pres  
**Organization:** Channel Technologies  
**Component:** Electro-optical Industries, Inc.  
**Address:** 859 Ward Dr.  
Santa Barbara, CA 93111  
**Notes:** Research on infrared and visible blackbody radiant energy standards, radiometry, electro-optical instrumentation, microwave standards, low-level instrumentation, industrial temperature measurement, and radiation thermometry.

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**Contact Name:** J.A. Cutts  
**Position:**  
**Organization:** California Institute of Technology  
**Component:**  
**Address:** 1201 East California Boulevard  
Pasadena, CA 91125  
**Notes:** Co-authored for 1990 IEEE Meeting on Advanced IR Detectors "Space Science Applications of Infrared Detector Technology: A Review"

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**Contact Name:** John Dahmes  
**Position:** Executive Manager, Marketing  
**Organization:** Intergraph Corp.  
**Component:**  
**Address:** 2051 Mercator Drive  
Reston, VA 22091  
**Notes:** Thermal Imaging, imaging software for military applications.

**Contact Name:** M. Dal Colle  
**Position:**  
**Organization:** Fraunhofer-Institut fur Angewandte Festkorperphysik  
**Component:**  
**Address:** Tullastr. 72  
D-7800 Freiburg, Germany  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials  
"Characterization of Anodic Fluoride Films on HgCdTe"

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**Contact Name:** Hugh Danaher  
**Position:**  
**Organization:** UTI Instruments  
**Component:**  
**Address:**  
**Notes:**

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**Contact Name:** Craig Davidson  
**Position:**  
**Organization:** Vision Harvest  
**Component:**  
**Address:** HCR Box 36  
Hatch, NM 87937  
**Notes:** active in infrared process control

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**Contact Name:** C. de Cambray  
**Position:** Public Relations Executive  
**Organization:** SAGEM  
**Component:**  
**Address:** 6, avenue d'Iena  
75783 Paris, Decex 16, FRANCE  
**Notes:** Infrared equipment & systems, detectors and sensors, c.o systems, night vision,  
robotics for military applications.

**Contact Name:** William De La Torre  
**Position:** Mr,  
**Organization:** Research Opportunities, Inc.  
**Component:**  
**Address:** 2200 Hamipola Court Suite 101  
Torrance, CA 90501  
**Notes:** Designer of infrared non-destructive evaluation system at research opportunities.

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**Contact Name:** Li De-Chun  
**Position:**  
**Organization:** Shandong University  
**Component:** Infrared and Remote Sensing Re.  
**Address:** Jinan, Shandong, CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "The Dependence of Fermi Level of HgCdTe on Impurity Concentration and Temperature"

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**Contact Name:** A. Deepak  
**Position:** President  
**Organization:** Science & Technology Corp  
**Component:**  
**Address:** 101 Research Dr., PO Box 7390  
Hampton, VA 23666  
**Notes:** Remote sensing, laser beams, c/o sensors, and lidars, aerosols, fogs and hazes, climate, space, and environmental quality.

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**Contact Name:** John Dehne  
**Position:** Pres  
**Organization:** Loral Corporation  
**Component:** Loral Infrared & Imaging Systems, Inc.  
**Address:** 2 Forbes Rd.  
Lexington, MA 02173  
**Notes:** R&D of electro-optical systems and components.

**Contact Name:** Nancy C. DelGrande  
**Position:** Ms.  
**Organization:** Lawrence Livermore National Laboratories  
**Component:**  
**Address:** Livermore, CA 94551  
**Notes:** Active in infrared remote sensing, designed dual-band IR system using MWIR and LWIR detectors simulateneously to overcome emissivity problems.

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**Contact Name:** Brian Denley  
**Position:**  
**Organization:** Loral Corporation  
**Component:** Loral Infrared & Imaging Systems, Inc.  
**Address:** 2 Forbes Rd.  
Lexington, MA 02173  
**Notes:**

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**Contact Name:** Roberta L. Denny  
**Position:** Ms.  
**Organization:** Rockwell International Corporation  
**Component:** Electro-Optics Center  
**Address:** 3370 Miraloma Avenue  
Anaheim, CA 92803  
**Notes:** Leader of Rockwell EOC's Man/Tec research including producibility work on focal plane arrays.

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**Contact Name:** Dave Derby  
**Position:** Pres  
**Organization:** Datron Systems, Inc.  
**Component:**  
**Address:** 200 W Los Angeles Ave.  
Simi Valley, CA 93065-1650  
**Notes:** Production and research in infrared optical and laser sensors.

**Contact Name:** Eustace Dereniak  
**Position:**  
**Organization:** University of Arizona  
**Component:** Optical Sciences Center  
**Address:** Tucson, AZ 85721  
**Notes:** active in infrared process control

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**Contact Name:** E.L. Derenial  
**Position:**  
**Organization:** University of Arizona  
**Component:** Optical Sciences Center  
**Address:** Tucson, AZ 85721  
**Notes:** Co-Author in 1992 SPIE meeting of "Development of a High-Speed PtSi IRCCD Camera System"

---

**Contact Name:** M.R. Descour  
**Position:**  
**Organization:** University of Arizona  
**Component:** Optical Sciences Center  
**Address:** Tucson, AZ 85721  
**Notes:** Co-authored for 1992 IRFPA SPIE meeting "Functional aspects of the retina relating to infrared focal plane arrays"

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**Contact Name:** Joseph DeSimone  
**Position:** Pres.  
**Organization:** Silicon Casting Inc.  
**Component:**  
**Address:** 2616 Mercantile Drive  
Rancho Cordova, CA 95742  
**Notes:** Manufacturer of silicon in various shapes for infrared applications.

**Contact Name:** G. Destefanis  
**Position:**  
**Organization:** LETI (CEA - Technologies Avancees)  
**Component:** DOPT - CEN/G - 85 X  
**Address:** F38041 Grenoble Cedex FRANCE  
**Notes:** Co-authored for 1992 MCT Workshop "Large Improvement in HgCdTe Photovoltaic Detector Performances at LETI"

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**Contact Name:** Bob Deuple  
**Position:** Dr.  
**Organization:** Thayer School of Engineering  
**Component:** Biophysics Dept  
**Address:** Hanover, NH 03755  
**Notes:** active in infrared biomedical thermography

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**Contact Name:** Roger DeVilbiss  
**Position:** Product Marketing Manager  
**Organization:** Marlow Industries, Inc.  
**Component:**  
**Address:** 10451 Vista Park Road  
Dallas, TX 75238  
**Notes:** Manufactures thermoelectric cooling devices, thermoelectric cooling assemblies, and related power supplies and temperature controllers

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**Contact Name:** C.F. Dewey  
**Position:**  
**Organization:** MIT  
**Component:**  
**Address:** Cambridge, MA 02139  
**Notes:** Co-authored for 1991 MCT Workshop "Nonlinear Optical Effects in Rotationally Twinned CdTe and CdMnTe Crystals"

**Contact Name:** John Dimmock  
**Position:** Gmgr  
**Organization:** McDonnell Douglas Corporation  
**Component:** MD Research Laboratories  
**Address:** PO Box 516  
Saint Louis, MO 63166  
**Notes:** Infrared detectors and fluid dynamics.

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**Contact Name:** Qian Dingrong  
**Position:**  
**Organization:** Laboratory for Infrared Physics  
**Component:** Academia Sinica  
**Address:** 420 Zhong Shan Bei Yi Road  
Shanghai, 200083, CHINA  
**Notes:** Authored for 1992 SPIE meeting on IRFPAs "Element of a new Infrared Detector Plasma Edge Detector"

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**Contact Name:** Peter Drenzo  
**Position:** Gnl Mgr  
**Organization:** Cleveland Crystals, Inc.  
**Component:**  
**Address:** 19306 Redwood Avenue, P.O Box 17157 Cleveland, OH 44117  
**Notes:** Manufacturer and research into CdTe, ZnS, and ZnSe infrared materials for both military and commercial markets.

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**Contact Name:** Robert Dixon  
**Position:**  
**Organization:** Tektronix, Inc.  
**Component:**  
**Address:** 26600 Southwest Parkway  
Beaverton, OR 97077  
**Notes:** infrared non-destructive evaluation

**Contact Name:** M. Dobrowolska  
**Position:**  
**Organization:** University of Notre Dame  
**Component:** Department of Physics  
**Address:** Notre Dame, IN 46556  
**Notes:** Co-authored for 1991 MCT Workshop "Magnetic Generation of electrons and Holes in Semimetallic HgTe-CdTe Superlattices"

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**Contact Name:** Alan Doctor  
**Position:** Sales & Marketing Manager  
**Organization:** Servo Corporation of America  
**Component:**  
**Address:** 111 New South Road  
Hicksville, NY 11802  
**Notes:** Manufactures thermistors and pyroelectric IR detectors, IR optical components, IR telescope assemblies, custom IR systems, and coating materials.

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**Contact Name:** Brad Doetzel  
**Position:** CEO  
**Organization:** Avimo USA, Inc.  
**Component:**  
**Address:** 716 S Milwaukee Ave.  
Wheeling, IL 91702  
**Notes:** Product oriented research in night vision optics and custom optical components, used mainly by the military.

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**Contact Name:** Robert Donadio  
**Position:** Pres  
**Organization:** Morton International  
**Component:** CVD Incorporated  
**Address:** 185 New Boston St.  
Woburn, MA 01801  
**Notes:** Material sciences, novel optical concepts and laser applications.



**Contact Name:** D. Donnelly  
**Position:**  
**Organization:** Sam Houston State University  
**Component:** Department of Physics  
**Address:** Huntsville, TX 77341  
**Notes:** Co-authored "Properties of InAs/(Ga,In)Sb Strained Layer Superlattices Grown on the (111) Orientations" for 1992 MCT Workshop

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**Contact Name:** F.P. Doty  
**Position:**  
**Organization:** Aurora Technologies Corp.  
**Component:**  
**Address:** San Diego, CA 92121-2410  
**Notes:** Co-authored for 1991 MCT Workshop "Properties of CdZnTe Crystals Grown by a High Pressure Bridgman Method." Has conducted CZT related research

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**Contact Name:** Irwin Drangel  
**Position:** Sales Manager  
**Organization:** United Mineral and Chemical Corp.  
**Component:**  
**Address:** 1100 Valley Brook Avenue  
Lyndhurst, NJ 07071-3608  
**Notes:** Manufacture of CdTe, GaAs, germanium, and ZnS for infrared applications.

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**Contact Name:** Alfred D. Ducharme  
**Position:**  
**Organization:** University of Central Florida  
**Component:** Electrical Engineering Department and Center for Research in Electro-Optics and Lasers  
**Address:** 12424 Research Parkway, Suite 400  
Orlando, FL 32828  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Use of Narrowband Laser Speckle for MTF Characterization of CCDs"

**Contact Name:** Michael Dudley  
**Position:**  
**Organization:** SUNY at Stony Brook  
**Component:** Department Materials Sci & Eng  
**Address:** Stony Brook, NY 11794-2275  
**Notes:** Attended 1992 MCT conference

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**Contact Name:** Benjamin Duhow  
**Position:** V.P. Defense Programs  
**Organization:** Thomson-CSF  
**Component:**  
**Address:** 2231 Crystal Drive, Suite 814  
Arlington, VA 22202  
**Notes:** Infrared equipment and systems, detectors and sensors

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**Contact Name:** James Dunn  
**Position:** Pres  
**Organization:** Loral Corporation  
**Component:** Loral Fairchild Systems  
**Address:** 300 Robbins Ln.  
Syosset, NY 11791  
**Notes:** Development of electro-optical imaging systems.

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**Contact Name:** Ronny Dunn  
**Position:** Infrared Program Manager  
**Organization:** Texas Instruments  
**Component:** Defense Systems and Electronics Group  
**Address:** POB 660246 MS 3139  
Dallas, TX 75266  
**Notes:**

**Contact Name:** J.A. Dura  
**Position:**  
**Organization:** University of Houston  
**Component:** Department of Physics and Space Vacuum Epitaxy Center  
**Address:** Houston, TX 77204  
**Notes:** Co-authored "Properties of InAs/(Ga,In)Sb Strained Layer Superlattices Grown on the (111) Orientations" for 1992 MCT Workshop

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**Contact Name:** Dan Dusel  
**Position:** Vice President, marketing.  
**Organization:** Merlin Engineering  
**Component:**  
**Address:** 1888 Embarcadero Road  
Palo Alto, CA 94303  
**Notes:** Thermal imaging, infrared systems & equipment for military markets.

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**Contact Name:** Frans Eberth  
**Position:**  
**Organization:** FLIR Systems, Inc.  
**Component:**  
**Address:** 16505 SW 72nd Avenue  
Portland, OR 97224  
**Notes:** Infrared non-destructive evaluation specialist.

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**Contact Name:** Kip Edgley  
**Position:** Electrical/Instrumentation Specialist  
**Organization:** Envirotech Operating Services  
**Component:**  
**Address:** 18820 Aurora Avenue North  
Vancouver, WA 98133  
**Notes:** Large western thermographic predictive maintenance firm, consultants

**Contact Name:** D.D. Edwall  
**Position:**  
**Organization:** Fraunhofer-Institut für Angewandte Festkörperphysik  
**Component:**  
**Address:** Tullastr. 72  
D-7800 Freiburg, Germany  
**Notes:** AAuthor of "Characterization of MCT Heterostructures by Thermoelectric Measurements"

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**Contact Name:** Jeff Edwards  
**Position:** Communications Manager  
**Organization:** Evans & Sutherland  
**Component:**  
**Address:** 600 Komas Drive  
Salt Lake City, UT 84108  
**Notes:** Night Vision, thermal imaging for military applications.

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**Contact Name:** D. Eger  
**Position:**  
**Organization:** Soreq Nuclear Research Center  
**Component:**  
**Address:** ISRAEL  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Anodic Oxides on HgZnTe"

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**Contact Name:** H. Ehrenreich  
**Position:**  
**Organization:** Harvard University  
**Component:** Division of Applied Sciences  
**Address:** 29 Oxford Street  
Cambridge, MA 92138  
**Notes:** Co-Author of "Augur Lifetimes in Ideal InGaSb/InAs Superlattices" for 1992 MCT Workshop.

**Contact Name:** Hassan Ehsani  
**Position:**  
**Organization:** Rensselaer Polytechnic Institute  
**Component:**  
**Address:** 110 Eight Street  
Troy, NY 12180  
**Notes:** Co-authored "Improved CdTe Layers on GaAs and Si Substrates, Grown by Atomic Layer Epitaxy" for 1992 MCT Workshop  
  
Co-Author for 1991 Workshop "Low Temperature Epitaxy of HgTe, CdTe, and HgCdTe Using FLOW Modulation Techniques" and "Reduced Metal-Insulator Semiconductor Tunnelling in MOCVD HgCd(111)Te Films"

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**Contact Name:** Robert Einzig  
**Position:** Pres  
**Organization:** Optical Technologies, Inc.  
**Component:**  
**Address:** Suite 1200, 360 Herndon Pkwy  
Herndon, VA 22070  
**Notes:** Research and development of fiber optic sensors for the measurement of physical parameters.

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**Contact Name:** Steven Eisenbath  
**Position:** Pres  
**Organization:** Peda-Scan Infrared Service, Inc.  
**Component:**  
**Address:** 1932 Olde Eisenbath Ln.  
Foristell, MO 63348  
**Notes:** Consultant doing research for industry; thermal evaluation of performance of products.

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**Contact Name:** David Eisenhaure  
**Position:** Pres  
**Organization:** Satcon Technology Corp.  
**Component:**  
**Address:** 12 Emily ST.  
Cambridge, MA 02139-4507  
**Notes:** Power electronics and system integration.

**Contact Name:** Jan Eklund  
**Position:** President  
**Organization:** Eklund Infrared  
**Component:**  
**Address:** 142 Sunset Avenue  
Verona, NJ 07044  
**Notes:** Eklund Infrared markets AGEMA's systems in US. Eklund is on SPIE's Thermosense steering committee

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**Contact Name:** Sylvester N. Ekpenuma  
**Position:**  
**Organization:** Claflin College  
**Component:** Department of Mathematics and Physics  
**Address:** Orangeburg, South Carolina 29115  
**Notes:** Co-authored for 1991 MCT Workshop "Critical Stress of HgCdTe Solid Solutions" and "Microhardness of Hg-Containing II-VI Alloys"

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**Contact Name:** Joel Elftmann  
**Position:** Pres  
**Organization:** FSI International  
**Component:**  
**Address:** 322 Lake Hazeltine Dr.  
Chaska, MN 55318  
**Notes:** Research for semiconductor production equipment.

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**Contact Name:** Dr. Herbert Elion  
**Position:** CEO  
**Organization:** International Optical Telecommunications  
**Component:**  
**Address:** 18 E Blithedale Ave.  
Mill Valley, CA 94941-1916  
**Notes:** Hardware and software market research including lab facilities, design improvement and patenting technology assistance.

**Contact Name:** Earle Ellefsen  
**Position:** Pres.  
**Organization:** Pure Tech Inc.  
**Component:**  
**Address:** P.O. Box 1319  
Carmel, NY 10512  
**Notes:** Manufacture of CdTe, germanium, silicon, ZnS, and ZnSe for infrared applications.

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**Contact Name:** WJ Elsdoefer  
**Position:** Pres  
**Organization:** International Machine & Tool Corp.  
**Component:** Instrument & Development Laboratory  
**Address:** 115 Maple St.  
Warwick, RI 02888  
**Notes:** Electronic and optical measurement development.

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**Contact Name:** Earnest Emery  
**Position:** CEO  
**Organization:** E2 Technology corp.  
**Component:**  
**Address:** 4475 Dupont Ct., No 9  
Ventura, CA 93003  
**Notes:** Product oriented research in infrared blackholes.

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**Contact Name:** Michel Engelhardt  
**Position:**  
**Organization:** Grumman Aircraft Systems  
**Component:**  
**Address:** MS B46-35  
Bethpage, NY 11714  
**Notes:** Active in infrared process control design and integration for Grumman.

**Contact Name:** Gerald Entine  
**Position:** Pres  
**Organization:** Radiation Monitoring Devices, Inc.  
**Component:**  
**Address:** 44 Hunt St.  
Watertown, MA 02172  
**Notes:** Manufacture of cadium telluride for infrared applications.

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**Contact Name:** David E. Escobar  
**Position:**  
**Organization:** USDA - ARS  
**Component:** Remote Sensing Research Unit  
**Address:** 2413 E. Highway 83  
Weslaco, TX 79586  
**Notes:** active in infrared remote sensing

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**Contact Name:** I. Esquivias  
**Position:**  
**Organization:** Fraunhofer-Institut fur Angewandte Festkorperphysik  
**Component:**  
**Address:** Tullastr. 72  
D-7800 Freiburg, Germany  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials  
"Characterization of Anodic Fluoride Films on HgCdTe"

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**Contact Name:** Paul Everett  
**Position:** Manager, Business Development  
**Organization:** Litton Electron Devices  
**Component:**  
**Address:** 1215 S. 52nd Street  
Tempe, AZ 85281  
**Notes:** E/O systems, night vision devices, infrared systems and equipment, produced for military markets.



**Contact Name:** James H. Everitt  
**Position:**  
**Organization:** USDA - ARS  
**Component:** Remote Sensing Research Unit  
**Address:** 2413 E. Highway 83  
Weslaco, TX 79596  
**Notes:** active in infrared remote sensing

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**Contact Name:** Gerald Falbel  
**Position:** Chmn  
**Organization:** Optical Energy  
**Component:**  
**Address:** 472 Westover Rd  
Stamford, CT 06902  
**Notes:** Research into electro-optical engineering.

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**Contact Name:** Mary Fallon  
**Position:** Ms.  
**Organization:** Inframetrics  
**Component:**  
**Address:** 16 Esquire Drive  
Billerica, MA 01862  
**Notes:**

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**Contact Name:** T. Fanning  
**Position:**  
**Organization:** SUNY at Stony Brook  
**Component:** Department of Materials Science & Engineering  
**Address:** Stony Brook, NY 11794-2275  
**Notes:** AAuthor of "White Beam X-ray Synchrotron Topography Analysis of CdTe (111)B Substrates and Epilayers

**Contact Name:** Lorenzo Faraone  
**Position:**  
**Organization:** University of West Australia  
**Component:** Department of EE  
**Address:** Nedlands, Perth, Western Australia 6009  
**Notes:** Attended 1992 MCT conference

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**Contact Name:** Frank Fariello  
**Position:** Pres  
**Organization:** EDO Corporation  
**Component:** Barnes Engineering Company  
**Address:** 88 Long Hill Cross Rd.  
Shelton, CT 06484  
**Notes:** Manufactures thermal and photon detectors, micro-thermal imagers, spectrum analyzers, space instrumentation, ncluding horizon sensors, IR microscopes, and IR instrumentation for research and industry.

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**Contact Name:** Vahne Farkissian  
**Position:** Pres  
**Organization:** Silicon Valley Group, Inc.  
**Component:**  
**Address:** 2240 Ringwood Ave.  
San Jose CA 95131  
**Notes:** Semiconductor wafer processing equipment.

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**Contact Name:** Cathleen M. Farley  
**Position:** Ms.  
**Organization:** BDM Inc.  
**Component:**  
**Address:** 4001 North Fairfax Drive  
Arlington, VA 22203  
**Notes:** Authored for 1992 SPIE workshop on IRFPAs "Modeling the Cost and Producibility Impacts of IRFPA Operability"

**Contact Name:** Diane Farrar  
**Position:** Ms.  
**Organization:** NASA Ames Research Center  
**Component:**  
**Address:** Mountain View, CA 94035-1000  
**Notes:** Designed airborne fire monitoring system used, most notably, to assist oakland firefighters during October 1991 blaze

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**Contact Name:** Heinz Fassmer  
**Position:**  
**Organization:** Eltro GmbH, Gesellschaft fur Strahlungstechnik  
**Component:** Euromissile Group  
**Address:** W-2878 Berne 2/ Motzen-Weser  
Germany  
**Notes:** Produces HgCdTe-based infrared guidance systems for military applications.

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**Contact Name:** Jean-Paul Faurie  
**Position:**  
**Organization:** University of Illinois  
**Component:** Microphysics Lab  
**Address:** Chicago, IL  
**Notes:** Authored November 1989 "MBE Growth: Characterization and Electronic Device Processing of HgCdTe, HgZnTe. Related Heterojunctions and HgCdTe-CdTe Superlattices"

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**Contact Name:** J.P. Faurie  
**Position:**  
**Organization:** University of Illinois at Chicago  
**Component:** Microphysics Laboratory, Physics Department  
**Address:** PO Box 4348, M/C 273  
Chicago, IL 60680  
**Notes:** Authored "Structure of CdTe(111)B grown by MBE on Misoriented Si(001)," and "Influence of CdZnTe(211)B Substrate on Electrical Properties of HgCdTe Grown by MBE" for 1992 MCT Workshop.  
On Program Committee of 1991 & 1992 MCT Workshop  
For 1991 Workshop, "Current Status of Direct Growth of CdTe and HgCdTe on Silicon by MBE"

**Contact Name:** L.D. Favro  
**Position:**  
**Organization:** Wayne State University  
**Component:** Insitute for Manufacturing Research  
**Address:** Detroit, MI 48202  
**Notes:** Expert in infrared NDE. Authored in 1990 a 7 page "Noise Suppresion in IR Thermal-Wave Video Images by Real-Time Processing in Synchronism with Active Stimulation of the Target"

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**Contact Name:** Terry Feeley  
**Position:** Pres  
**Organization:** Laser Fare, Inc.  
**Component:**  
**Address:** One Industrial Dr S  
Esmond, RI 02917  
**Notes:** Applied laser technology to industrial materials processing; research in aerospace, medical and electronic applications, includes IR illumination.

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**Contact Name:** Wu Fci-fei  
**Position:**  
**Organization:** Shandong University  
**Component:** Infrared and Remote Sensing Rc.  
**Address:** Jinan, Shandong, CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "The Dependence of Fermi Level of HgCdTe on Impurity Concentration and Temperature"

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**Contact Name:** A. Fenigstein  
**Position:**  
**Organization:** Kidron Microelectronics Research Center  
**Component:** Department of Electrical Engineering  
**Address:** Technion-Israel Institute of Technology  
Haifa 32000, ISRAEL  
**Notes:** For 1991 MCT, Workshop Co-authored "Covered Electrode HgCdTe Photoconductor Under High Illumination Levels"

**Contact Name:** F. Fernandez  
**Position:** President  
**Organization:** Vinten-Penarroya Inc.  
**Component:**  
**Address:** 17151 Newhope Street, Suite 208  
Fountain Valley, CA 92708  
**Notes:** Manufacture of germanium for infrared applications.

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**Contact Name:** E. Finkman  
**Position:**  
**Organization:** Kidron Microelectronics Research Center  
**Component:** Department of Electrical Engineering  
**Address:** Technion-Israel Institute of Technology  
Haifa 32000, ISRAEL  
**Notes:** For 1991 MCT Workshop Co-authored "Covered Electrode HgCdTe  
Photoconductor Under High Illumination Levels"

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**Contact Name:** Patrick Finney  
**Position:**  
**Organization:** FLIR Systems, Inc.  
**Component:**  
**Address:** 16505 SW 72nd Avenue  
Portland, OR 97224  
**Notes:** Active in setting up infrared predictive maintenance and IC board inspection  
regimes for FLIR systems

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**Contact Name:** John Fitts  
**Position:** Pres  
**Organization:** EOIS  
**Component:**  
**Address:** Suite 501, 710 Wilshire Blvd.  
Santa Monica, CA 90401  
**Notes:** High-energy laser beam control systems, smart sensor technology, moir  
interferometry, wavefront sensors, algorithm development.

**Contact Name:** Brian Fitzpatrick  
**Position:** President  
**Organization:** Optical Semiconductors Inc.  
**Component:**  
**Address:** 8 John Walsh Blvd, Suite 421  
Peekskill, NY 10566-5330  
**Notes:** Manufacture of ZnS and ZnSe for infrared systems for both military and commercial markets.

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**Contact Name:** L.M. Flath  
**Position:**  
**Organization:** University of Arizona  
**Component:** Optical Sciences Center  
**Address:** Tucson, AZ 85721  
**Notes:** Author in 1992 SPIE meeting of "Development of a High-Speed PtSi IRCCD Camera System"

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**Contact Name:** Terry Fleener  
**Position:** Manager, Business Development  
**Organization:** Ball Electro-Optics and Cryogenics Div.  
**Component:**  
**Address:** P.O. Box 1062  
Boulder, CO 80306  
**Notes:** Thermal Imaging, Active and Passive EO systems for military market.

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**Contact Name:** Michael Florimbi  
**Position:** CEO  
**Organization:** BEI Electronics Company, Inc.  
**Component:** BEI Defense Systems Company, Inc.  
**Address:** 11312 S Pipeline Rd., PO Box 155429  
Fort Worth, TX 76155  
**Notes:** Product-oriented research, development, testing and evaluation on photoelectric shaft position encoders.

**Contact Name:** James Fogle  
**Position:** VP  
**Organization:** Kollmorgen Corporation  
**Component:** Photo Research  
**Address:** 9330 DeSoto Dr.  
Chatsworth, CA 91311  
**Notes:** Optical and electromechanical light measuring devices.

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**Contact Name:** S. Robert Foley  
**Position:** VP Marketing and Planning  
**Organization:** Raytheon Company  
**Component:**  
**Address:** 141 Spring Street  
Lexington, MA 02173  
**Notes:**

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**Contact Name:** M.A. Folkard  
**Position:**  
**Organization:** CMTEK Pty, Ltd  
**Component:**  
**Address:** P.O. Box 1500  
Salisbury 5108, South Australia  
**Notes:** Co-authored for 1992 MCT Workshop "In-Situ Ellipsometric Measurements of the MBE Growth of CdTe/HgTe and CdTe/ZnTe Superlattices"

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**Contact Name:** John Ford  
**Position:** Public Relations Manager  
**Organization:** GEC Ferranti  
**Component:**  
**Address:** Ferry Road  
Edinburgh, Scotland EH5 2XS  
**Notes:** Night vision, detectors and sensors, active and passive eo systems for military applications.

**Contact Name:** Leann M. Forister  
**Position:** Ms.  
**Organization:** EnTech Engineering, Inc.  
**Component:**  
**Address:** 111 Marine Lane  
St. Louis, MO 63146  
**Notes:** Active in infrared remote sensing, having devised the IR/GPR technique.

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**Contact Name:** E.R. Fossum  
**Position:**  
**Organization:** Columbia University  
**Component:**  
**Address:** New York, NY  
**Notes:** Co-authored for 1990 SPIE workshop on IR Detectors "GaAs CCD Readout for Engineered Bandgap Detectors"

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**Contact Name:** Tom Fournier  
**Position:** President  
**Organization:** Dynatech Corporation  
**Component:** Sensors, Inc.  
**Address:** 6812 S State Rd  
Saline MI 48176  
**Notes:** Commercial uses for infrared technology, infrared gas analysis, zirconia oxygen analyzer on OEM basis

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**Contact Name:** David Fraser  
**Position:** Pres  
**Organization:** Fraser-Volpe Corporation  
**Component:**  
**Address:** Warminster Industrial Park, 1025 Thomas Dr.  
Warminster PA 18974  
**Notes:** Electro-optics and electronic systems; design and development of systems for inspection of fluid-filled vials and other glass containers to detect chips, cracks and foreign particles, stabilization systems for optical viewing devices, television and motion picture cameras, laser stabilization.



**Contact Name:** James Frey  
**Position:** Pres  
**Organization:** Litton Industries, Inc.  
**Component:** Itek Optical Systems  
**Address:** 10 Maguire Rd.  
Lexington, MA 02173  
**Notes:** Optics, electro-optics and systems research for image based systems.

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**Contact Name:** John Fried  
**Position:** Vice President  
**Organization:** Batelle Memorial Institute  
**Component:** Manufacturing Systems  
**Address:** 505 King Ave.  
Columbus OH 43201  
**Notes:** Assists manufacturing with front-end planning and analysis aimed at increasing productivity and quality, reducing cost and improving capacity.

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**Contact Name:** Marvin Friedman  
**Position:** Director of Marketing  
**Organization:** North Atlantic Industries, Inc.  
**Component:**  
**Address:** 60 Plant Avenue  
Hauppauge, NY 11788-3890  
**Notes:** Thermal imaging for military applications.

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**Contact Name:** Myles Friedman  
**Position:** Pres MyPres  
**Organization:** Southwest Engineering  
**Component:**  
**Address:** 714 First National Bank Bldg.  
Fort Smith, AR 72901  
**Notes:** Computer/electronic controls for manufacturing processes, has experimented with IR detectors.

**Contact Name:** James Fritz  
**Position:**  
**Organization:** ISI Group  
**Component:**  
**Address:** 211 Conchas SE  
Albuquerque, NM 87123  
**Notes:** Active in infrared process control development. ISI group manufactures thermal-imaging TV systems based on pyroelectric vidicon tubes.

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**Contact Name:** Elizabeth Fuchs  
**Position:** Ms.  
**Organization:** Sandia National Laboratory  
**Component:**  
**Address:** ORG 8246  
P.O. Box 969  
Livermore, CA 94551  
**Notes:** Specialist in NDE thermal imagers. On SPIE's Thermosense steering committee.

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**Contact Name:** Elizabeth A. Fuchs  
**Position:** Ms.  
**Organization:** Sandia National Labs  
**Component:**  
**Address:** ORG 8246  
P.O. Box 969  
Livermore, CA 94511  
**Notes:** Active in infrared remote sensing system design, using dual-band MWIR and LWIR IR technology technique.

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**Contact Name:** Ken Fujiwara  
**Position:** President  
**Organization:** Epitaxx, Inc.  
**Component:**  
**Address:** 3490 Route 1,  
Princeton, NJ 08540  
**Notes:** Long-wavelength high speed sources and detectors for fiberoptic communications (InGaAs photodiodes, 1300 & 1500 nm edge LED and laser diode), large area InGaAs detectors for test and measurement rangefinding. Develops 512 element InGaAs arrays of cutoff wavelengths of 2.6um.

**Contact Name:** J.K. Furdyna  
**Position:**  
**Organization:** University of Notre Dame  
**Component:**  
**Address:** Notre Dame, IN 46556  
**Notes:** On Program Committee of 1992 MCT Workshop  
For 1991 Workshop co-authored "Magnetic Generation of Electrons and Holes in Semimetallic HgTe-CdTe Superlattices"

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**Contact Name:** Kevin Fynn  
**Position:**  
**Organization:** University of Western Australia  
**Component:** Department of Electrical Engineering  
**Address:** Nedlands, Perth, Western Australia  
**Notes:** Attended 1992 MCT Workshop

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**Contact Name:** M. Gal  
**Position:**  
**Organization:** University of New South Wales  
**Component:** School of Physics  
**Address:** Kensington 2033 AUSTRALIA  
**Notes:** Co-Author of "In-Situ Ellipsometric Measurements of the MBE Growth of CdTe/HgTe and CdTe/AlTe Superlattices" for 1992 MCT Workshop

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**Contact Name:** Dr Tom Galantowicz  
**Position:** CEO  
**Organization:** Newport Corporation  
**Component:**  
**Address:** 18235 Mount Baldy Circle  
Fountain Valley, CA 92708  
**Notes:** Electro-optic and electro-mechanical components and systems for laser optical applications.

**Contact Name:** Mosten Gale  
**Position:**  
**Organization:** SBRC  
**Component:**  
**Address:** 75 Coromar Drive  
Goleta, CA 93117  
**Notes:**

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**Contact Name:** Dr Charles Garber  
**Position:** Pres  
**Organization:** Structure Probe  
**Component:**  
**Address:** 569 E Gray St., PO Box 656  
West Chester, PA 19381-0656  
**Notes:** X-ray diffraction and thermal analysis.

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**Contact Name:** Tony Gardiner  
**Position:** Pres  
**Organization:** Osprey Sub-Sea, Inc  
**Component:**  
**Address:** 1225 Stone Dr.  
San Marcos, CA 92069  
**Notes:** Night vision equipment and acoustic tracking systems for military applications.

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**Contact Name:** Bruce Gardner  
**Position:** Pres.  
**Organization:** Janos Technology, Inc.  
**Component:**  
**Address:** HCR #33, Box 25  
Townshend, VT 05353-7702  
**Notes:** Manufacturer of CdTe, GaAs, germanium, silicon, ZnS, and ZnSe for infrared applications.

**Contact Name:** James Garner  
**Position:**  
**Organization:** Infrared Research, Inc.  
**Component:**  
**Address:** 100 Park City Road  
Roosville, GA 30741  
**Notes:** Active in infrared predictive maintenance as a consultant who helps set up inspection regimes.

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**Contact Name:** Bill Gary  
**Position:**  
**Organization:** Vision Harvest  
**Component:**  
**Address:** HCR Box 36  
Hatch, NM 87937  
**Notes:** active in infrared process control

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**Contact Name:** Charles Gay  
**Position:** Pres  
**Organization:** Arco Solar Inc  
**Component:**  
**Address:** 4650 Adohr Ln., PO Box 6032  
Camarillo, CA 93010  
**Notes:** Advanced and applied research and development of photovoltaic devices and systems. Production continues of square foot panels with Commer Indium Diselenide (CIS) coated with Cadmium Sulfide. CIS is increasingly viewed as the most promising material for solar power.

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**Contact Name:** Peter Gaylord  
**Position:**  
**Organization:** Total Vision Photonics  
**Component:**  
**Address:** 39 Vaughn Street, Suite 202  
Ottawa, CANADA K1M1W9  
**Notes:** active in infrared process control

**Contact Name:** Boris Gelmont  
**Position:**  
**Organization:** Virginia University  
**Component:** Department of Electrical Engineering  
**Address:** Charlottesville, VA  
**Notes:** Co-authored May 1992 report "Monte Carlo Simulation of Electron Transport in HgCdTe"

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**Contact Name:** R. Gentilman  
**Position:** Pres.  
**Organization:** Phase 4 Infrared  
**Component:**  
**Address:** P.O. Box 2647  
Acton, MA 01720  
**Notes:** Manufacturer of ZnS and ZnSe for infrared applications, both military and commercial.

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**Contact Name:** John Georg  
**Position:** Public Relations Manager  
**Organization:** Litton Corporation  
**Component:**  
**Address:** 1725 Jefferson Davis Highway  
Suite 601, Crystal Square Two  
Arlington, VA 22203  
**Notes:** E/o systems, night vision, infrared systems and equipment, detectors & sensors for military.

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**Contact Name:** S.K. Ghandhi  
**Position:**  
**Organization:** Rensselaer Polytechnic Institute  
**Component:**  
**Address:** 110 Eight Street  
Troy, NY 12180  
**Notes:** Co-Chairman along with Loral's P.W. Norton of the 1992 MCT Workshop.  
On Program Committee of 1991 MCT Workshop  
  
Co-authored for 1991 Workshop "Low Temperature Epitaxy of HgTe, CdTe, HgCdTe using Flow Modulation Techniques"

**Contact Name:** David Gilblom  
**Position:**  
**Organization:** Sierra Scientific  
**Component:**  
**Address:** 605 West California Avenue  
Sunnyvale, CA 94086  
**Notes:** Active in infrared process control. Sierra designs, develops, and manufactures high performance CCD and tube cameras, video display monitors, x-ray image intensifiers and digital angiography subtraction systems. Used for machine vision, robotics, industrial radiology inspection, scientific research, microscopy and various custom applications.

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**Contact Name:** Ken Gilkey  
**Position:** VP for Marketing  
**Organization:** Cincinatti Electronics  
**Component:** Device & Microcircuits Labs Div  
**Address:** 7500 Innovation Way  
Mason, OH 45040-9699  
**Notes:** Manufactures and designs IR detectors including single-element, linear and two dimensional arrays, discrete channel amplified, multiplexed, in Ge, MCT, InSb and InAs, 1-12 um.

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**Contact Name:** Bob Gill  
**Position:** President  
**Organization:** Laser Diode Inc.  
**Component:**  
**Address:** 205 Forrest Street  
Metuchen, NJ 08840-1292  
**Notes:** Manufacturer of GaAs and germanium materials for infrared applications.

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**Contact Name:** John Gillespi  
**Position:** Pres  
**Organization:** Jodon Engineering  
**Component:**  
**Address:** 62 Enterprise Dr.  
Ann Arbor, MI 48103  
**Notes:** Optical engineering for machine vision, interest in IR detectors.

**Contact Name:** BM Gillespi  
**Position:** Pres  
**Organization:** Mobil Oil Corp.  
**Component:** Mobil Solar Energy Corp.  
**Address:** 4 Suburban Park Dr.  
Billerica, MA 01821  
**Notes:** Solar cell and photovoltaic power components and systems development.

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**Contact Name:** J.E. Gilpin  
**Position:** Manger Detector Products  
**Organization:** Rockwell International Corporation  
**Component:** Electro-Optical Center  
**Address:** 3370 Miraloma Ave.  
Anaheim, CA 92803  
**Notes:** Has represented Rockwell EOC's representative in the JM consortium

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**Contact Name:** S. Goettig  
**Position:**  
**Organization:** Wayne State University  
**Component:** Department of Physics  
**Address:** Detroit MI  
**Notes:** Co-authored 1990 "FORMATION MECHANISMS OF INTERSTITIAL DEFECT STATES"

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**Contact Name:** Merivn Goff  
**Position:** Dr.  
**Organization:** King's College  
**Component:** Thermal Biology Unit  
**Address:** Campden Hill Road, Kensington  
London, W8 7AH, UNITED KINGDOM  
**Notes:** Active in infrared biomedical thermography, widely published. System designer, longtime researcher.



**Contact Name:** Martin Goland  
**Position:** Pres  
**Organization:** Southwestern Research Institute  
**Component:**  
**Address:** Program Development Office, PO Drawer 28510  
San Antonio, TX 78228-0510  
**Notes:** Infrared research including automation and space research applications.

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**Contact Name:** T.D. Golding  
**Position:**  
**Organization:** Cambridge University  
**Component:** Cavendish Lab  
**Address:** Cambridge, UNITED KINGDOM  
**Notes:** Co-authored October 1988 "MBE of HgCdTe" available from DTIC. Active in MCT-based research for military applications.

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**Contact Name:** T.D. Golding  
**Position:**  
**Organization:** University of Houston  
**Component:** Department of Physics and Space Vacuum Epitaxy Center  
**Address:** Houston, TX 77204  
**Notes:** Co-authored "Properties of InAs/(Ga,In)Sb Strained Layer Superlattices Grown on the (111) Orientations" for 1992 MCT Workshop

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**Contact Name:** E. Goo  
**Position:**  
**Organization:** University of Southern California  
**Component:** Department of Materials Science and Engineering  
**Address:** Los Angeles, CA 90089-0241  
**Notes:** Co-authored for 1991 MCT Workshop "Ordered Phase in (HgCd)Te Grown by LPE on CdTe (111)B Substrate"

**Contact Name:** J.S. Goodling  
**Position:**  
**Organization:** Auburn University  
**Component:**  
**Address:**  
**Notes:** Co-authored 1988 "Adaptive Welding Using Infrared Sensing Techniques Manufacturing Processes, Machines and Systems"

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**Contact Name:** DAVID K. GORDON  
**Position:** Marketing Director  
**Organization:** Autometric, Inc.  
**Component:**  
**Address:** 5301 Shawnee Road  
Alexandria, VA 22312  
**Notes:** Active in IR remote sensing. Broad spectrum remote sensing and reconnaissance systems organization, photogrammetric engineering, image interpretation and analysis, photogrammetric mapping and map-based information system development

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**Contact Name:** Lawrence Goshorn  
**Position:** CEO  
**Organization:** Iri Vision  
**Component:**  
**Address:** Suite D, 6231 Yarrow Dr.  
Carlsbad, CA 92009  
**Notes:** Product-oriented research of light-based vision systems, interest in IR systems.

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**Contact Name:** Srini Govindan  
**Position:** Dr.  
**Organization:**  
**Component:**  
**Address:** Professional Center 1, Suite 206  
Medical Park  
Wheeling, WV 26003  
**Notes:** Doctor in private practice, active in infrared biomedical thermography

**Contact Name:** Thorsten Graeve  
**Position:**  
**Organization:** University of Arizona  
**Component:** Optical Sciences Center  
**Address:** Tucson, AZ 85721  
**Notes:** active in infrared process control

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**Contact Name:** Thorsten Graeve  
**Position:**  
**Organization:** University of Arizona  
**Component:** Optical Sciences Center  
**Address:** Tucson, AZ 85629  
**Notes:** Graduate student who oversaw the center's study on the use of infrared spectra reflectances to sort pecans. Believes his technique has many other applications in food sorting in general

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**Contact Name:** Richard J. Graf  
**Position:**  
**Organization:** EnTech Engineering, Inc.  
**Component:**  
**Address:** 111 Marine Lane  
St, Louis, MO 63146  
**Notes:** Active in infrared sensing. Designed joint IR/GPR technique.

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**Contact Name:** F.J. Graham  
**Position:** Marketing Support Exec  
**Organization:** GEC Ferranti Defence Systems, Ltd.  
**Component:**  
**Address:** Navigation and Electro Optics Division  
Silverknowes, Ferry Road  
Edinburgh, UK EH4 4AD  
**Notes:** Infrared systems and equipment, night vision c/o systems for military applications.

**Contact Name:** Herbert Gram  
**Position:** Pres  
**Organization:** Spectrogram Corp.  
**Component:**  
**Address:** 385 State St.  
North Haven, CT 06473  
**Notes:** General research in the field of electro-optics, with a major effort on computer-based optical spectrum analysis as applied to analytical systems.

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**Contact Name:** R. Granger  
**Position:**  
**Organization:** Lab de Physique des Solides/ INSA  
**Component:**  
**Address:** FRANCE  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Infrared Reflectivity: A tool for bond Investigation in II-VI Ternaries"

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**Contact Name:** R.W. Grant  
**Position:**  
**Organization:** California Institute of Technology  
**Component:**  
**Address:** 1201 East California Boulevard  
Pasadena, CA 91125  
**Notes:** Reported at the DARPA Program Review on Infrared Focal Plane Array Technology in December, 1992, on "InAs/GaInSb Superlattices: Growth Involving Anion Switching"

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**Contact Name:** Steven E. Green  
**Position:**  
**Organization:** University of Nebraska  
**Component:** Center for Electro-Optics  
**Address:** Lincoln, NE 68588  
**Notes:** active in infrared remote sensing

**Contact Name:** William Greenlaw  
**Position:**  
**Organization:** Martin Marietta  
**Component:**  
**Address:** 103 Chesapeake Park Plaza  
Mail point 110  
Baltimore, MD 21220

**Notes:**

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**Contact Name:** C.H. Grein  
**Position:**  
**Organization:** Harvard University  
**Component:** Division of Applied Sciences  
**Address:** 29 Oxford Street  
Cambridge, MA 02138  
**Notes:** Co-Authored "Augur Lifetimes in Ideal InGaSh/InAs Superlattices" for 1992 MCT Workshop.

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**Contact Name:** DR Kurt Grimm  
**Position:** Pres  
**Organization:** Pharm-Eco Laboratories  
**Component:**  
**Address:** 2355 Chain Dr.  
Simi Valley, CA 93065  
**Notes:** Infrared research, gas chromatography and wet chemical tests.

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**Contact Name:** Manfred W. Grindel  
**Position:** President  
**Organization:** Continental Optical Corp.  
**Component:**  
**Address:** 15 Power Drive  
Hauppauge, NY 11788  
**Notes:** Manufacturer of silicon, ZnS, and ZnSe infrared materials for both military and commercial markets.

**Contact Name:** Ann Grizzel  
**Position:** Manager, Public Relations  
**Organization:** Westinghouse Electric Corp.  
**Component:** Electronics Systems Division  
**Address:** P.O. Box 17319  
MS A255  
Baltimore, MD 21203-6812

**Notes:** Infrared systems and equipment, detectors and sensors, c/o systems

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**Contact Name:** K. Groom  
**Position:**  
**Organization:** Auburn University  
**Component:**  
**Address:**

**Notes:** Co-authored 1988 "Adaptive Welding Using Infrared Sensing Techniques  
Manufacturing Processes, Machines and Systems"

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**Contact Name:** Paul Grover  
**Position:**  
**Organization:** Infraspction Institute  
**Component:**  
**Address:** 1971 Shelburne Road, Suite C  
Shelburne, VT 05482

**Notes:** Active in infrared predictive maintenance as a training and information  
dissemination and trade society for thermographers.

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**Contact Name:** George Guilbalt  
**Position:** President  
**Organization:** Universal Sensors, Inc.  
**Component:**  
**Address:** Suite D, 5258 Veterans Blvd.  
Metairie, LA 70006

**Notes:** Development of advanced biosensors and immunosensors for medical  
applications.

**Contact Name:** Xu Guo-Sen  
**Position:**  
**Organization:** Shanghai Institute of Technical Physics  
**Component:** Acadmia Sinica  
**Address:** Shanghai, 200081 CHINA  
**Notes:** Co-authored for 1992 SPIE conference on IRFPAs "The Dependence of Fermi Level of HgCdTe on Impurity Concentration and Temperature"

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**Contact Name:** Xu Guosen  
**Position:**  
**Organization:** Shanghai Institute of Technical Physics  
**Component:** Academia Sinica  
**Address:** China 200083  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "The Effect of Shockley-Read Recombination on Minority Carrier Lifetime of HgCdTe"

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**Contact Name:** Xu Guoxen  
**Position:**  
**Organization:** Shanghai Institute of Technical Physics  
**Component:** Academia Sinica  
**Address:** Shanghai, CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Study of the Recombination Mechanisms and Carrier Lifetimes in HgCdTe Alloy"

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**Contact Name:** Robert Guyton  
**Position:** Pres  
**Organization:** Universal Technology Corp.  
**Component:**  
**Address:** 4031 Colonel Glenn Hwy.  
Dayton, OH 45431  
**Notes:** Development of advanced manufacturing technologies for metal working and electronic research and development.

**Contact Name:** Omer Hageniers  
**Position:** Pres  
**Organization:** Diffracto Ltd.  
**Component:**  
**Address:** 2835 Kew Dr.  
Windsor, ON N8T 3B7  
**Notes:** Research in vision sensors and gas lasers for measuring purposes for industry.

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**Contact Name:** Yubong Hahn  
**Position:** Pres  
**Organization:** Rocky Mountain Instrument Co.  
**Component:**  
**Address:** 1501S Sunset St.  
Longmont, CO, 80501  
**Notes:** Manufacture of precision optical components and multilayer thin film coatings.

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**Contact Name:** Robert G. Hammaker  
**Position:**  
**Organization:** Electric Power Research Institute  
**Component:**  
**Address:** 3 Industrial Highway  
Eddystone, PA 19022  
**Notes:** Active in infrared predictive maintenance, activist among electric power utilities with inspecito of overhead power lines as well as plant equipment.

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**Contact Name:** Albert E. Hammett  
**Position:**  
**Organization:** Southern Nuclear Operating Center  
**Component:**  
**Address:** 40 Inverness Center Parkway  
Birmingham, AL 35242  
**Notes:** Active in infrared predictive maintenance. Set up Southern nuclear's inspection regime, purchased their equipment.



**Contact Name:** P.H. Handel  
**Position:**  
**Organization:** Minnesota University  
**Component:** Department of Electrical Engineering  
**Address:** Minneapolis, MN  
**Notes:** Co-authored August 1991 "Quantum Noise in Solid-State Devices in Particular HgCdTe Diodes"

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**Contact Name:** William Hanley  
**Position:** CEO  
**Organization:** Galileo Electro-Optics Corp.  
**Component:**  
**Address:** Galileo Park, PO Box 550  
Sturbridge, MA 01566  
**Notes:** Develops fiber-optic and electro-optic components which transmit, intensify or sense light images.

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**Contact Name:** Timothy Hannemann  
**Position:** VP  
**Organization:** TRW Inc  
**Component:** TRW Electronic Systems Group  
**Address:** E Bldg., Rm 5076, One Space Park  
Redondo Beach, CA 90278  
**Notes:** Development of advanced infrared sensor technologies.

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**Contact Name:** Walter Hanser  
**Position:** Marketing Director  
**Organization:** Buck Werke GMBH & Co.  
**Component:**  
**Address:** Hans-Buck-Strasse 1  
D-7844 Neuenburg, GERMANY  
07631  
**Notes:** Services, Infrared Systems and Equipment for military markets.

**Contact Name:** Yuan Haoxin  
**Position:**  
**Organization:** Shanghai Institute of Technical Physics  
**Component:** Chinese Academy of Sciences  
**Address:** Shanghai, 20092 CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "HgCdTe Photovoltaic Detectors and Some Related Aspects"

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**Contact Name:** Larry Hardin  
**Position:** President  
**Organization:** Hardin Optical Company  
**Component:**  
**Address:** P.O. Box 219  
1320 Oregon Avenue  
Bandon, OR 97411  
**Notes:** Manufacture of GaAs, germanium, silicon, ZnS, and ZnSe for infrared applications. commercial and military.

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**Contact Name:** E.T. Harlimagean  
**Position:**  
**Organization:** R&D Institute for Semiconductor Devices  
**Component:**  
**Address:** ROMANIA  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Accurate Method for Neutron Fluence Control Used in Improving Neutron-Transmutation-Doped Silicon Detectors"

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**Contact Name:** Thomas Harris  
**Position:** Pres  
**Organization:** Optical Research Associates  
**Component:**  
**Address:** 550 N Rosemead Blvd.  
Pasadena, CA 91107  
**Notes:** Research in optical design engineering, some for IR detectors.

**Contact Name:** R.H. Hartley  
**Position:**  
**Organization:** Surveillance Research Laboratory  
**Component:**  
**Address:** DSTO  
O.I, Bix 1500  
Salisbury, South Australia, 5108  
**Notes:** Co-authored for 1991 MCT Workshop "Real Time Control of the MBE Growth of CdHgTe and CdTe/GhTe Superlattices Using Ellipsometry"

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**Contact Name:** Christopher Harz  
**Position:** VP Mkt.  
**Organization:** Perceptronics Incorporated  
**Component:**  
**Address:** 21135 Erwin Street  
Woodland Hills, CA 91365-4198  
**Notes:** Has been awarded several government contracts to conduct research and development of computer aided manufacturing processes for IRFPAs.

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**Contact Name:** J Hassan  
**Position:** Vice President for Technology  
**Organization:** AMP Incorporated  
**Component:** AMP Technology, Electro-optics Division  
**Address:** PO Box 3608  
Harrisburg, PA 17105-3608  
**Notes:** Applied and product-oriented research and development on fiber optic, electro-optic, passive, and interconnection devices.

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**Contact Name:** George Hatsopoulos  
**Position:** Pres  
**Organization:** Thermo Electron Corp.  
**Component:**  
**Address:** 101 First Ave.,  
Waltham, MA 02254  
**Notes:** Production of optics, electro-optics, electro-acoustic systems.

**Contact Name:** Patsy Hattox  
**Position:** Vice President  
**Organization:** Nichols Research Corp.  
**Component:**  
**Address:** 4040 South Memorial Parkway  
Huntsville, AL 35802  
**Notes:** Infrared systems and equipment, imaging software for military markets.

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**Contact Name:** Greg Haug  
**Position:**  
**Organization:** Compaq Computer  
**Component:**  
**Address:** P.O. Box 692000  
Houston, TX 77269-2000  
**Notes:** Set up infrared inspection regime for compaq's computer chips and IC boards

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**Contact Name:** Robert Haugh  
**Position:** Pres  
**Organization:** Overhead Door Corp  
**Component:** Horton Automatics Division  
**Address:** 1900 Crown Dr.  
Farmers Branch, TX 75234  
**Notes:** Applied research on pneumatics, electrical and fluidic technology, door-and-window automation and associated sensing devices, microwave and infrared sensing technology.

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**Contact Name:** Shahram Hejazi  
**Position:** Dr.  
**Organization:** Eastman Kodak Company  
**Component:** Health Sciences Division  
**Address:** 100 Carlson Road  
Rochester, NY 14653-9015  
**Notes:** Formerly at SUNY Buffalo, where he patented a multi-band IR biomedical thermography instrument.

**Contact Name:** Shahram Hejazi  
**Position:** Senior Engineer  
**Organization:** Eastman Kodak, Inc.  
**Component:** Health Sciences Division  
**Address:** 100 Carlson Road  
Rochester, NY 14653-9015  
**Notes:** Doctoral research discussed in Nov. 92 OE article on using thermal imagers, MCT-based, at multiwavelengths, to determine skin temperature.

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**Contact Name:** Donald Heller  
**Position:** Sales and Marketing  
**Organization:** Agema Infrared Systems  
**Component:**  
**Address:** 142 Sunset Avenue  
Verona, NJ 07044  
**Notes:** Active in infrared predictive maintenance application development at Agema

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**Contact Name:** C.R. Helms  
**Position:**  
**Organization:** Stanford University  
**Component:** Solid State Lab  
**Address:** McCullough 114  
Stanford, CA 94305  
**Notes:** On Program Committee of 1992 MCT Workshop, Co-Chairman of 1991 MCT Workshop.  
For 1991 Workshop, co-authored "Thermodynamic Description of metal Hg(Cd)Te Systems"

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**Contact Name:** alan Henry  
**Position:** Gmgr  
**Organization:** Harris Corporation  
**Component:** Government Communications Systems Division  
**Address:** 256 SE Palm Bay Rd., PO Box 9100  
Melbourne, FL 32902  
**Notes:** Satellite and terrestrial communications, electro-optics, imagery and voice privacy systems for military.

**Contact Name:** Gregg Herbison  
**Position:** National Sales Manager  
**Organization:** Thomson Components & Tubes Corp  
**Component:** TCS Division  
**Address:** 40 G Commerce Eay  
Totowa, NJ 07511  
**Notes:** Infrared systems and equipment, GaAs gate arrays, detectors & sensors

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**Contact Name:** Mathew Heric  
**Position:**  
**Organization:** Autometric, Inc.  
**Component:**  
**Address:** 5301 Shawnee Road  
Alexandria, VA 22312  
**Notes:** Also active in IR remote sensing research and system design

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**Contact Name:** F.P. Hermann  
**Position:** Corp. Foreign Press and Adv. Mgr.  
**Organization:** Israel Aircraft Industries, Ltd.  
**Component:**  
**Address:** Ben-Gurion International Airport  
Israel 70100  
**Notes:** Passive and active e/o components, detectors and sensors, infrared systems and equipment for military applications.

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**Contact Name:** Theresa Herpst  
**Position:** Pres  
**Organization:** International Crystal Laboratories  
**Component:**  
**Address:** 11 Eric St.  
Garfield, NJ 07026  
**Notes:** Applied research for growing crystals for infrared transmission.

**Contact Name:** N. Hess  
**Position:**  
**Organization:** Dresden University of Technology  
**Component:** Institut fur Festkorperelektronik  
**Address:** Dresden, FEDERAL REPUBLIC OF GERMANY  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Pyroelectric Linear Array IR Detectors with CCD Multiplexer"

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**Contact Name:** F. Hicks  
**Position:**  
**Organization:** University of California, Los Angeles  
**Component:** Department of Chemical Engineering  
**Address:** Los Angeles, CA 90024-1592  
**Notes:** Co-authored for 1991 MCT Workshop "Photoassisted Organometallic VPE on CdTe"

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**Contact Name:** A. Ray Hilton  
**Position:** President  
**Organization:** Amorphous Materials Inc.  
**Component:**  
**Address:** 3130 Benton Street  
Garland, TX 75042  
**Notes:** Infrared materials production of CdTe, GaAs, and silicon, mainly for military.

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**Contact Name:** Bruce Hinman  
**Position:** Dir. Business Development and Contracts  
**Organization:** Spar Aerospace, Ltd.  
**Component:** Applied Systems Group  
**Address:** 365 March Road  
Kanata, Ontario, CANADA K2K 1X3  
**Notes:** E.o systems, infrared systems & equipment, night vision for military applications.

**Contact Name:** LaVerne Hinsen  
**Position:** Sales Manager  
**Organization:** Fermionics Corp.  
**Component:**  
**Address:** 4555 Runway Street  
Simi Valley, CA 93063

**Notes:**

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**Contact Name:** Paul Hitchen  
**Position:** Marketing Comm. Mgr.  
**Organization:** Raytheon Submarine Signal Division  
**Component:**  
**Address:** 1847 West Main Road  
Portsmouth, RI 02871

**Notes:** Thermal imaging, detectors and sensors for military applications.

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**Contact Name:** G. Hofmann  
**Position:**  
**Organization:** Dresden University of Technology  
**Component:** Institut fur Festkorperelektronik  
**Address:** Dresden, FEDERAL REPUBLIC OF GERMANY  
**Notes:** Co-authored for 1992 SPIE IRFPA meeting "Pyroelectric IR Single-Element Detectors and Arrays Based on LiNbO3 and LiTaO3"

Co-authored for 1991 SPIE meeting on Growth of IR materials "Pyroelectric Linear Array IR Detectors with CCD Multiplexer"

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**Contact Name:** D.K. Hohnke  
**Position:**  
**Organization:** Ford Motor Company  
**Component:** Scientific Research Laboratory  
**Address:** Room S-2308  
P.O. Box 2053  
Dearborn, MI 48121-2053

**Notes:** Interested in designing IR inspection system to nondestructively test paint delaminations in cars



**Contact Name:** David Holland  
**Position:** Managing Director  
**Organization:** Davin Optical, Ltd.  
**Component:**  
**Address:** 9A Chester Road  
Borehamwood, Herts, UK WD6 1LD  
**Notes:** Night Vision, EO Systems, Infrared Systems and Equipment, Thermal Imaging for military applications

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**Contact Name:** M. Hollander  
**Position:** National Sales Manager  
**Organization:** Atomergic Chemetals Corporation  
**Component:**  
**Address:** 222 Sherwood Avenue  
Farmingdale, NY 11735  
**Notes:** Material processing of CdTe, GaAs, Germanium, Silicon, ZnS, and ZnSe, predominantly for military markets. For commercial markets, basic and applied research involving inorganic chemistry, rare elements and ultra-purity metals and chemicals, spherical and submicron powders, single crystal, electronic and solid state materials, hotpressed ceramics, stable isotopes deuterated compounds, liquid crystals, pharmaceuticals, etc.

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**Contact Name:** Dag Holmsten  
**Position:**  
**Organization:** Total Vision Photonics, Inc.  
**Component:**  
**Address:** 39 Vaughn Street, Suite 202  
Ottawa, CANADA K1M1W9  
**Notes:** active in infrared process control

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**Contact Name:** Ludwig Holtermann  
**Position:** owner  
**Organization:** Concept Engineering  
**Component:**  
**Address:** 43 Ragged Rock Rd.  
Old Saybrook, CT 06475  
**Notes:** Manufactures optical test and measurement equipment including IR thermometers, radiant fluxmeters, and solar radiometers/ photometers. IR-technology sensor and detector development.

**Contact Name:** Alexander Horvath  
**Position:** General Manager  
**Organization:** General Electric Company  
**Component:** Aerospace Electronics Systems Department  
**Address:** French Rd.  
Utica, NY 13503  
**Notes:** Research into pattern recognition, using IR detectors.

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**Contact Name:** Warren Howell  
**Position:** Dvmgr  
**Organization:** Bio-Rad Laboratories, Inc.  
**Component:** Digilab Division  
**Address:** 237 Putnam Ave.  
Cambridge, MA 02139  
**Notes:** Product-oriented research in applications for existing technology in new fields including Transform-Infrared spectroscopy, gas chromatography and infrared technology.

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**Contact Name:** Patricia A. Howell  
**Position:** Ms.  
**Organization:** NASA, Langley Research Center  
**Component:** Analytical Services and Manufacturing, Inc.  
**Address:** c/o MS 231  
Hampton, VA 23665  
**Notes:** Infrared non-destructive evaluation, mainly for aging aircraft skins and advanced composites.

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**Contact Name:** Kuo-Tung Hsu  
**Position:**  
**Organization:** Chung-Shan Institute of Science and Technology  
**Component:**  
**Address:** Lung-Tan, Taiwan, REPUBLIC OF CHINA  
**Notes:** Co-authored for 1992 SPIE IRFPA meeting "Electrolyte Electrorreflectance Spectroscopies for the Ion-Implanted HgCdTe with Thermal Annealing"

**Contact Name:** Kuo-Tung Hsu  
**Position:**  
**Organization:** National Taiwan University  
**Component:** Department of Electrical Engineering  
**Address:** Taipei, Taiwan, REPUBLIC OF CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Electrolyte Electroreflectance Spectroscopies for the Ion-Implanted HgCdTe with Thermal Annealing"

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**Contact Name:** Chao Huang  
**Position:**  
**Organization:** Tsing-Hua University  
**Component:** Material Center  
**Address:** 101, Sec 2 Kunag-Rd.  
Hsingchu, Taiwan, ROC  
**Notes:**

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**Contact Name:** Jack Hubbard  
**Position:** Dr.  
**Organization:** University of Minnesota School of Medicine  
**Component:** Minneapolis Clinic of Neurology  
**Address:** 305 East Nichols Boulevard  
Ridgeview Medical Bldg, Suite 185  
Burnsville, MN 55337  
**Notes:** active in infrared biomedical thermography

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**Contact Name:** Frank Huerta  
**Position:**  
**Organization:** SBRC  
**Component:**  
**Address:** 75 Coromar Drive  
Goleta, CA 93117  
**Notes:**

**Contact Name:** John Hughes  
**Position:** Dr.  
**Organization:** Clinical Research Centre  
**Component:** Division of Rheumatology  
**Address:** Watford Road, Harrow,  
UNITED KINGDOM  
**Notes:** Active in use of infrared biomedical thermography for arthritis and rheumatism.

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**Contact Name:** William C. Hughes  
**Position:**  
**Organization:** University of North Carolina at Chapel Hill  
**Component:** Department of Physics and Astronomy  
**Address:** Phillips Hall, CB #3255  
Chapel Hill, NC 27599-3255  
**Notes:** Co-Authored "Observation of Indium-Vacancy and Indium Hydrogen Interactions in (HgCd)Te Using PAC"

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**Contact Name:** Paul Hughett  
**Position:**  
**Organization:** Hughett Research  
**Component:**  
**Address:** 2110 Cedar Street #B  
Berkeley, CA 94709-1515  
**Notes:** Active in infrared predictive maintenance regime design.

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**Contact Name:** Donald Hutchinson  
**Position:** Marketing Director  
**Organization:** Tau Corporation  
**Component:**  
**Address:** Los Gatos, CA  
**Notes:**

**Contact Name:** Ronald Huynh  
**Position:** Pres  
**Organization:** Advanced Kinetics  
**Component:**  
**Address:** Unit 108, 18281 Gothard St.  
Huntington Beach, CA 92648  
**Notes:** Research in laser physics and applications, including IR sources (black bodies).

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**Contact Name:** Dr. M.Y. Hwang  
**Position:** Ch. Sci  
**Organization:** JTT International Inc.  
**Component:**  
**Address:** 3045 Technology Pkwy  
Orlando, FL 32826  
**Notes:** Manufacturer of germanium, silicon, ZnS, and ZnSe infrared systems.

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**Contact Name:** Anthony Charles Ibbott  
**Position:**  
**Organization:** California Institute of Technology  
**Component:** Jet Propulsion Laboratory  
**Address:** 4800 Oak Grove Drive  
Pasadena, CA 91109-8099  
**Notes:** Designed airborne fire monitoring system for JPL

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**Contact Name:** Anthony C. Ibbott  
**Position:**  
**Organization:** California Institute of Technology  
**Component:** Jet Propulsion Laboratory  
**Address:** 4800 Oak Grove Drive  
Pasadena, CA 91109-8099  
**Notes:** active in infrared remote sensing

**Contact Name:** K. Irani  
**Position:**  
**Organization:** Mikron Instruments  
**Component:**  
**Address:** 445 W. Main Street  
Wyckoff, NJ 07481  
**Notes:** Manufactures and markets non-contact infrared temperature measurement and control systems, portable infrared thermometers, thermal imaging systems, temperature sensors for OEM applications and black body calibration sources.

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**Contact Name:** Bernard J. Isker III  
**Position:**  
**Organization:** Hughes Aircraft Company  
**Component:** Technology Center  
**Address:** 6155 El Camino Real  
Carlsbad, CA 92009  
**Notes:** Authored for 1992 SPIE Workshop on IRFPAs "Cryoprobe Test Development"

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**Contact Name:** Anthony Jacobini  
**Position:** VP Mfg  
**Organization:** International Crystal Laboratories  
**Component:**  
**Address:** 11 Eric St.  
Garfield, NJ 07026  
**Notes:** Manufacture of CdTe, GaAs, germanium, silicon, ZnS, and ZnSe for infrared products.

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**Contact Name:** Doug James  
**Position:** Systems Engineer  
**Organization:** Kollmorgen Corp.  
**Component:**  
**Address:** 347 King Street  
Northampton, MA 01060  
**Notes:** Detectors and sensors, infrared systems and equipment, night vision for military applications.

**Contact Name:** James Jamieson  
**Position:** President  
**Organization:** Jamieson Science and Engineering  
**Component:**  
**Address:** 7315 Wisconsin Avenue, Suite 447W  
Washington, DC 20814  
**Notes:** Advocate of MCT being able to overcome cost barriers to break into commercial market. Long history of involvement in IR since advent.

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**Contact Name:** Gwo-Jen Jan  
**Position:**  
**Organization:** National Taiwan University  
**Component:** Department of Electrical Engineering  
**Address:** Taipei, Taiwan, REPUBLIC OF CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Electrolyte Electroreflectance Spectroscopies for the Ion-Implanted HgCdTe with Thermal Annealing"

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**Contact Name:** P. Tom Jenkins  
**Position:** General Manager  
**Organization:** DALSA Inc, CCD Image Sensors  
**Component:**  
**Address:** 605 McMurray Road  
Waterloo, Ontario CANADA N2V 2E9  
**Notes:** Specializes in manufacture, design, research and development of high performance, solid-state CCD image sensors and cameras. has a standard product line of 35 different CCD image sensors and 75 models of CCD imaging cameras, and actively pursues custom contracts and strategic alliances for CCD technology development.

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**Contact Name:** John Jenkofsky  
**Position:** Gmgr  
**Organization:** Irtronics Instruments, Inc.  
**Component:**  
**Address:** 132 Forest Blvd.  
Ardsley, NY 10502  
**Notes:** Standard and custom infrared radiation pyrometers for measuring temperature in industrial research applications.

**Contact Name:** Geir U. Jensen  
**Position:**  
**Organization:** Virginia University  
**Component:** Department of Electrical Engineering  
**Address:** Charlottesville, VA  
**Notes:** Co-authored May 1992 report "Monte Carlo Simulation of Electron Transport in HgCdTe"

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**Contact Name:** Arthur S. Jensen  
**Position:**  
**Organization:** Westinghouse Corp.  
**Component:** Advanced Technology Division  
**Address:** Baltimore, MD 21203  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Superconductive Circuits for On-FPA IR Digital Signal Processing"

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**Contact Name:** Fang Jia-Xiong  
**Position:**  
**Organization:** Shanghai Institute of Technical Physics  
**Component:** Academia Sinica  
**Address:** Shanghai, 200081 CHINA  
**Notes:** Co-authored for 1992 SPIE conference on IRFPAs "The Dependence of Fermi Level of HgCdTe on Impurity Concentration and Temperature"

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**Contact Name:** Fang Jiaxiong  
**Position:**  
**Organization:** Shanghai Institute of Technical Physics  
**Component:** Academia Sinica  
**Address:** Shanghai, CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Study of the Recombination Mechanisms and Carrier Lifetimes in HgCdTe Alloy"



**Contact Name:** Fang Jiaxong  
**Position:**  
**Organization:** Shanghai Institute of Technical Physics  
**Component:** Academia Sinica  
**Address:** Shanghai, China 200083  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "The Effect of Shockley-Read Recombination on Minority Carrier Lifetime of HgCdTe"

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**Contact Name:** Jorge Jimenez  
**Position:**  
**Organization:** Tufts University  
**Component:** Electro-Optics Technology Center  
**Address:** Medford, MA 02155  
**Notes:** Co-authored for 1992 meeting of SPIE on IRFPAs "Fundamental Studies of Schottky Barrier IR Detectors by Ballistic Electron Emission Microscopy"

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**Contact Name:** Yan Jing-Xuan  
**Position:**  
**Organization:** Qingdao University  
**Component:** Department of Computer and Information Science  
**Address:** Qingdao, Shandong, CHINA  
**Notes:** Co-authored for 1992 SPIE conference on IRFPAs "The Dependence of Fermi Level of HgCdTe on Impurity Concentration and Temperature"

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**Contact Name:** Yan Jingxuan  
**Position:**  
**Organization:** Qingdao University  
**Component:** Department of Computer and Information Science  
**Address:** 266071 Qingdao, Shandong, CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Study of the Recombination Mechanisms and Carrier Lifetimes in HgCdTe Alloy"

**Contact Name:** Raymond Johnson  
**Position:** General Manager  
**Organization:** General Electric Company  
**Component:** Aircraft Controls Systems Department  
**Address:** PO Box 5000  
Binghamton, NY 13902  
**Notes:** Research and development of sensing and sensors, in part with IR detectors.

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**Contact Name:** B.R. Johnson  
**Position:**  
**Organization:** Honeywell Corp.  
**Component:** Sensor and System Development Center  
**Address:** 10701 Lyndale Avenue South  
Bloomington, MN 55420  
**Notes:** Co-authored for 1992 SPIE Workshop on IRFPAs "YBa<sub>2</sub>Cu<sub>3</sub>O<sub>7</sub> Superconducting Microbolometer Linear Arrays" supported by DARPA with Office of Naval Research as contracting agency.

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**Contact Name:** Carl Johnson  
**Position:** President and CEO  
**Organization:** II-VI Inc.  
**Component:**  
**Address:** 375 Saxonburg Blvd  
Saxonburg, PA 16056  
**Notes:** Manufacture of CdTe, GaAs, germanium, silicon, ZnS, ZnSe for infrared applications.

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**Contact Name:** Jim Johnson  
**Position:** Dir. Commercial Products  
**Organization:** Loral Fairchild Imaging Sensors  
**Component:**  
**Address:** 1801 McCarthy Boulevard  
Milpitas, CA 95035  
**Notes:** Detectors and sensors, c/o systems, infrared systems & equipment, predominantly for military.

**Contact Name:** C. Barbara Johnson  
**Position:** Division Administrator  
**Organization:** Raytheon Co.  
**Component:** Electromagnetic Systems Div.  
**Address:** 6380 Hollister Avenue  
Goleta, CA 93117  
**Notes:** Detectors & sensors, e/o systems, infrared systems & equipment

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**Contact Name:** R.B. Johnson  
**Position:**  
**Organization:** University of Maryland  
**Component:**  
**Address:** College Park, MD  
**Notes:** Co-authored 1987 study "Phase Differences between Wuantum Oscillations of the Magnetoresistance and the Hall Effect in HgMnTe and HgCdTe"

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**Contact Name:** Rose Jones  
**Position:** Pres  
**Organization:** Muffoletto Optical Company, Inc  
**Component:**  
**Address:** 6100 Everall Ave.  
Baltimore, MD 21206  
**Notes:** Design and development of optical systems for underwater, laboratory and space applications.

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**Contact Name:** Pat Jones  
**Position:** Sales Manager  
**Organization:** Preh Electronic Inc.  
**Component:**  
**Address:** 470 E. Main  
Lake Zurich, IL 60047  
**Notes:** Infrared systems & equipment for military applications.

**Contact Name:** A.M. Joshi  
**Position:**  
**Organization:** EPITAXX, Inc.  
**Component:**  
**Address:** 3490 U.S. Route One  
Princeton, NJ 08540  
**Notes:** Co-authored for 1992 SPIE Workshop on IRFPAs "Popcorn Noise in Linear InGaAs Detector Arrays" Firm manufactures long-wavelength high speed sources and detectors for fiveroptic communications , esp. InGaAs.

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**Contact Name:** Shan Joshi  
**Position:** Pres  
**Organization:** Universal Energy Systems  
**Component:**  
**Address:** 4401 Dayton-Xenia Rd.  
Dayton, OH 45432  
**Notes:** Development and application of laser and electro-optic systems.

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**Contact Name:** Feng-Yuh Juang  
**Position:**  
**Organization:** Chung-Shan Institute of Science and Technology  
**Component:**  
**Address:** Lung-Tan, Taiwan, REPUBLIC OF CHINA  
**Notes:** Co-authored for 1992 SPIE IRFPA meeting "Electrolyte Electroreflectance Spectroscopies for the Ion-Implanted HgCdTe with Thermal Annealing"

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**Contact Name:** Sue Justice  
**Position:** Marketing Director  
**Organization:** EG&G, Inc.  
**Component:** EG&G Judson  
**Address:** 221 Commerce Dr.  
Montgomeryville, PA 18936  
**Notes:** Manufactures infrared detectors and arrays including Ge, InAs, InSb, MCT, and doped Ge

**Contact Name:** David Kales  
**Position:** Senior Editor, Markets  
**Organization:** Laser Focus World  
**Component:**  
**Address:** One Technology Park Drive  
P.O. Box 989  
Westford, MA 01886  
**Notes:** Wrote November 1992 article "Detector Makers Seek Dual-Use Technology for Survival." Friends with David Lecch.

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**Contact Name:** Alex Kalil  
**Position:** Pres  
**Organization:** Silonex Inc  
**Component:** Silonex, Inc  
**Address:** 2150 Ward St.  
Montreal CANADA PQ H4M 1T7  
**Notes:** Optoelectronics automation of manufacturing. Includes CdS photoconductive cells, optoisolators, LEDs, photodiodes and photodiode arrays, photovoltaic cells, phototransistors and photodarlington.

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**Contact Name:** Herbert Kaplan  
**Position:** President  
**Organization:** Honeyhill Technical Corporation  
**Component:**  
**Address:** 193 East Avenue  
Norwalk, CT 06855  
**Notes:** Contributing editor to Photonics Spectra, consultant in IR business, longtime SPIE leader of Thermosense meetings. Teaches courses for predictive maintenance engineers.

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**Contact Name:** Ronald Kappler  
**Position:** Pres.  
**Organization:** Kappler Crystal Optics Inc.  
**Component:**  
**Address:** 1244 Highland Street  
Holliston, MA 01746  
**Notes:** Manufacturer of ZnS and ZnSe for infrared applications.

**Contact Name:** N.H. Karam  
**Position:**  
**Organization:** Spire Corporation  
**Component:**  
**Address:** Bedford, MA 01730  
**Notes:** Co-authored for 1991 MCT Workshop "Low Temperature Epitaxy on HgTe, CdTe, and HgCdTe Using Flow Modulation Techniques"

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**Contact Name:** James P. Karins  
**Position:**  
**Organization:** Mission Research Corporation  
**Component:**  
**Address:** 735 State Street  
Santa Barbara, CA 93102  
**Notes:** Authored for 1992 SPIE workshop on IRFPAs "Models of Nonlinearities in Focal Plane Arrays"

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**Contact Name:** Dr Eskil Karlson  
**Position:** Dir  
**Organization:** Life Support, Inc.  
**Component:**  
**Address:** 2926 State St.  
Erie, PA 16509  
**Notes:** Optical system design including IR detection and systems for both military and commercial markets.

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**Contact Name:** John Kasprzak  
**Position:** Marketing Director  
**Organization:** Brimrose Corporation of America  
**Component:**  
**Address:** 5020 Campbell Blvd  
Baltimore, MD 21236  
**Notes:** Manufactures custom acousto-optic tunable filters , acousto-optic modulators and scanners, RF driver, and mercury manganese telluride infrared detectors. Provides to military and industry.

**Contact Name:** Timo Kaupinnen  
**Position:**  
**Organization:** Technical Research Center of Finland  
**Component:** Building Laboratory  
**Address:** P.O. Box 167  
SF-90101 Oulu, FINLAND  
**Notes:** infrared non-destructive evaluation

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**Contact Name:** Kenneth Kaylor  
**Position:** COO  
**Organization:** ATD, Inc.  
**Component:** Advanced Technology Division  
**Address:** PO Box 566  
Woodinville, WA 90872  
**Notes:** Applied R&D of video instrument systems including high-speed, IR microscopic and related research.

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**Contact Name:** Michael Keebaugh  
**Position:** Pres  
**Organization:** E-Systems, Inc.  
**Component:** HRB Systems, Inc  
**Address:** 300 Science Park Rd.  
State College, PA 16804  
**Notes:** Integration of sensors into systems capable of military surveillance missions.

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**Contact Name:** David Kennedy  
**Position:** Marketing Manager  
**Organization:** Optotex, Ltd.  
**Component:**  
**Address:** 62 Stencie Drive  
Kanata, Ontario, CANADA K2K 2A9  
**Notes:** GaAs gate arrays, infrared systems and equipment, rf systems and components

**Contact Name:** A. Kepten  
**Position:**  
**Organization:** Semi-conductor Devices, Inc.  
**Component:**  
**Address:** D.N. Misgav  
20179 ISRAEL  
**Notes:** Co-authored for 1992 SPIE Workshop on IRFPAs "p-Channel MIS Double-Metal Process InSb Monolithic Unit Cell for Infrared Imaging"

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**Contact Name:** W.D. Kerns  
**Position:**  
**Organization:** Johns Hopkins University  
**Component:** Center for NDE and Applied Physics Laboratory  
**Address:** Laurel, MD 20723  
**Notes:** infrared non-destructive evaluation

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**Contact Name:** Lawrence Kessler  
**Position:** Pres  
**Organization:** Diversified Optical Products  
**Component:**  
**Address:** 282 Main St.  
Salem, NH 03079  
**Notes:** Automated IR and visible automated MTF testing.

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**Contact Name:** David J. Kettler  
**Position:**  
**Organization:** Indiana State University  
**Component:** Department of Geography and Geology  
**Address:** Terre Haute, IN 47809  
**Notes:** Active in infrared remote sensing for a variety of natural resource assessments.



**Contact Name:** A.R. Khotanzad  
**Position:**  
**Organization:** Southern Methodist University  
**Component:**  
**Address:**  
**Notes:** Co-authored for 1992 SPIE meeting on Machine Vision "Automated Vision System for INSpection of Wedge Bonds"

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**Contact Name:** Edward Kielty  
**Position:**  
**Organization:** Sogem-Afrimet Inc.  
**Component:**  
**Address:** 1212 Avenue of the Americas  
New York, NY 10036  
**Notes:** Manufacturer of germanium for infrared applications.

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**Contact Name:** Ryoichi Kikuchi  
**Position:**  
**Organization:** Washington University  
**Component:** Department of Materials Science and Engineering  
**Address:** Seattle, WA  
**Notes:** Authored February 1988 study "Migration and Stability of HgCdTe Lattice Defects"

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**Contact Name:** Sun Ung Kim  
**Position:**  
**Organization:** Korea University  
**Component:**  
**Address:** Chong Am Dong  
Sung-Buk-Ku  
Seoul, KOREA 11136-701  
**Notes:** Attended 1992 MCT Workshop, a materials researcher.

**Contact Name:** Ki-Sang Kim  
**Position:**  
**Organization:** Virginia University  
**Component:** Department of Electrical Engineering  
**Address:** Charlottesville, VA  
**Notes:** Co-authored May 1992 report "Monte Carlo Simulation of Electron Transport in HgCdTe"

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**Contact Name:** Toh Kim-Huat  
**Position:** V.P./ General Manager  
**Organization:** CEI Technologies, PTE Ltd.  
**Component:**  
**Address:** 249 Jalan Boon Lay  
Singapore 2261  
**Notes:** Thermal imaging, night vision for military markets.

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**Contact Name:** M.A. Kinch  
**Position:** Dr.  
**Organization:** Texas Instruments  
**Component:** Infrared Materials Laboratory  
**Address:** POB 655936 MS150  
Dallas, TX 75265  
**Notes:** Head of their IR producibility effort; representative to JM consortium on producibility

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**Contact Name:** Tom Kinstle  
**Position:** Vice President Marketing  
**Organization:** Martin Marietta Corp.  
**Component:**  
**Address:** 6801 Rockledge Drive  
Bethesda, MD 20817  
**Notes:** Night vision, infrared systems & equipment for military markets.

**Contact Name:** R. Klauser  
**Position:**  
**Organization:** Fraunhofer-Institut für Angewandte Festkörperphysik  
**Component:**  
**Address:** Tullastr. 72  
D-7800 Freiburg, Germany  
**Notes:** AAuthor of "Characterization of MCT Heterostructures by Thermoelectric Measurements"

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**Contact Name:** Leonard Klencerman  
**Position:** Dr.  
**Organization:** Northwick Park Hospital  
**Component:** Dept of Orthopaedics  
**Address:** Watford Road  
Harrow, UNITED KINGDOM  
**Notes:** Active in research using infrared biomedical thermography for orthopaedic medicine.

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**Contact Name:** Hans Kluge  
**Position:** President  
**Organization:** Automatic Switch Co  
**Component:** Division of Emerson Electric Co.  
**Address:** 50-60 Hanover Road  
Florham Park, NJ 07932  
**Notes:** Cryogenic equipment for both commercial and military markets. Also product-oriented research of electric-power controls and fluid control devices to automate machinery, equipment, and industrial processes.

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**Contact Name:** Larry M. Klynn  
**Position:**  
**Organization:** Lockheed Missiles & Space Co., Inc.  
**Component:**  
**Address:** 1111 Lockheed Way  
Sunnyvale, CA 94088  
**Notes:** Infrared non-destructive evaluation of thermal profiles for smart missiles and automatic target recognition systems.

**Contact Name:** Guy Knockaert  
**Position:** Technico-commercial Manager  
**Organization:** Union Miniere  
**Component:**  
**Address:** A. Greinerstraat 14  
B-2660 Hoboken-Belgium

**Notes:**

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**Contact Name:** F. Koch  
**Position:**  
**Organization:** Technische Universtat  
**Component:** Physik-Department E-16  
**Address:** mUNCHEN, d-8046  
GERMANY  
**Notes:** Co-authored for 1991 MCT Workshop "Influence of Resonant Defect States on Subband Structures in HgCdTe"

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**Contact Name:** Bill Kolander  
**Position:** Product Marketing Manager  
**Organization:** Marlow Industries, Inc.  
**Component:**  
**Address:** 10451 Vista Park Road  
Dallas, TX 75238-1645  
**Notes:** Infrared systems & equipment, night vision, detectors and sensors, c/o systems for military markets.

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**Contact Name:** L. Kops  
**Position:**  
**Organization:** McGill University  
**Component:**  
**Address:** 845 Sherbrook St. W.,  
Montreal, PQ H3A 2T5  
**Notes:** Co-authored 1983 "Application of Infrared Radiation Measurements in Grinding Studies"

**Contact Name:** Edward Kornstein  
**Position:** Pres  
**Organization:** O R S Automation  
**Component:**  
**Address:** 402 Wall St.  
Princeton, NJ 08540  
**Notes:** Controls and guidance directed towards problems in machine vision for individual use, some work with IR.

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**Contact Name:** A.W. Koszykowski  
**Position:** Pres.  
**Organization:** Laser SOS Limited  
**Component:**  
**Address:** 4B Bartholomew's Walk  
Cambridgeshire Bus. Pk., ANgel Drove  
Ely, Camb. CB74EAG  
**Notes:** Manufacture of CdTe, GaAs, germanium, silicon, ZnS, and ZnSe for infrared applications.

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**Contact Name:** Lester J. Kozlowski  
**Position:** Dr.  
**Organization:** Rockwell International Science Center  
**Component:**  
**Address:** 1049 Camino Dos Rios  
Thousand Oaks, CA 91360  
**Notes:** Chief scientist conducting their alternative substrate programs; probably best connected and longest tenured Rockwell scientist doing IR

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**Contact Name:** M.G. Krauss  
**Position:**  
**Organization:** Dresden University of Technology  
**Component:** Institut fur Festkorperelektronik  
**Address:** Dresden, FEDERAL REPUBLIC OF GERMANY  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Pyroelectric Linear Array IR Detectors with CCD Multiplexer"

**Contact Name:** Harvey N. Kreisberg  
**Position:** Director Corporate Development  
**Organization:** AIL Systems, Inc.  
**Component:**  
**Address:** Commack Road  
Deer Park, NY 11729  
**Notes:** Manufactures Infrared systems & equipment, alongside RF & Microwave and other passive and active systems

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**Contact Name:** Kent Kresa  
**Position:** CEO  
**Organization:** Northrop Corporation  
**Component:** Hawthorne Site  
**Address:** 2301 W120th St  
Hawthorne CA 90250-5032  
**Notes:** Precision inertial sensors and lasers.

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**Contact Name:** Vikram Krishnamurthy  
**Position:**  
**Organization:** Stanford University  
**Component:** Department of Electrical Engineering  
**Address:** Stanford, CA 94305  
**Notes:** Co-Authored for 1991 MCT Workshop "Thermodynamic Description of metal HgCdTe Systems"

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**Contact Name:** Kenneth Kun  
**Position:** Pres  
**Organization:** Syracuse Research Corp.  
**Component:** Defense Electronics Engineering  
**Address:** Merrill Ln.  
Syracuse, NY 13210  
**Notes:** Optical and IR systems analysis.

**Contact Name:** Pao-Kuang Kuo  
**Position:**  
**Organization:** Wayne State University  
**Component:** Inst for Manufacturing Research  
**Address:** Detroit, MI 48202  
**Notes:** infrared non-destructive evaluation

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**Contact Name:** Audra Kurelaitis  
**Position:** Sales Manager  
**Organization:** Oxley, Inc.  
**Component:**  
**Address:** 25 Business Park Drive  
P.O. Box 814  
Branford, CT 06405  
**Notes:** E/o systems, night vision, infrared systems & equipment for military applications.

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**Contact Name:** Ernest Kussmaul  
**Position:** Pres  
**Organization:** Kussmaul Electronics Company, Inc.  
**Component:**  
**Address:** 170 Cherry Ave.  
West Sayville, NY 11796  
**Notes:** R&D of photoelectronic controls, interest in IR detectors.

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**Contact Name:** R. La Polla  
**Position:** Marketing Manager  
**Organization:** Whittaker Electronics  
**Component:**  
**Address:** 1785 Voyager Avenue  
Simi Valley, CA 93063-3349  
**Notes:** infrared systems & equipment

**Contact Name:** Stan Laband  
**Position:** Marketing Director  
**Organization:** Amber Engineering  
**Component:**  
**Address:** 5756 Stonewood Drive  
Goleta, CA 93117  
**Notes:** Participant in DARPA's IRFPA team and producer of InSb used in medium-wave infrared systems for both commercial and military systems

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**Contact Name:** Robert Lacer  
**Position:** Pres  
**Organization:** Infrared Scanning, Inc.  
**Component:**  
**Address:** 3955 Pleasantdale Rd.  
Atlanta, GA 30340  
**Notes:** Anfrared inspection techniques and applications.

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**Contact Name:** R.C. Lacoe  
**Position:**  
**Organization:** The Aerospace Corporation  
**Component:** Electronic Technology Center  
**Address:** P.O. Box 92957  
Los Angeles, CA 90009  
**Notes:** Co-authored for 1992 SPIE workshop on IRFPAs "Modified Wuantum Well Infrared Photodector Designs for High Temperature and Long Wavelength Operation"

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**Contact Name:** Dan Laerfeld  
**Position:** Marketing Manager  
**Organization:** Magnavox Electronic Systems Company  
**Component:** Electrto-Optical Systems  
**Address:** 46 Industrial Avenue  
Mahwah, NJ 07430-2206  
**Notes:** I.D.R. 001



**Contact Name:** Joseph Lakowicz  
**Position:**  
**Organization:** University of Maryland  
**Component:** Medical School  
**Address:** Baltimore, MD  
**Notes:** Speaking at OE/LASE Laser Market '93 seminar on wavelength requirements for medical diagnostics in the near-infrared spectral regions. The wavelength in such applications determines not only which molecules will absorb the light, but how deeply the light will penetrate biological tissues.

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**Contact Name:** K.C. Lamb  
**Position:** Marketing Manager  
**Organization:** MCP Wafer Technology  
**Component:**  
**Address:** Unit 34, Maryland Road, Tongwell, Milton Keynes, Bucks, MK158HJ  
UNITED KINGDOM  
**Notes:** Production of CdTe and GaAs for infrared applications.

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**Contact Name:** John Lamonica  
**Position:** President  
**Organization:** Farmers Investment Company  
**Component:**  
**Address:** P.O. Box 7  
Ahuarita, AZ 85629  
**Notes:** Invests in technologies which could benefit local farmers. Invested in infrared sorting technique for pecans which shows promise for sorting of many other varieties of fruits and vegetables.

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**Contact Name:** M.D. Lange  
**Position:**  
**Organization:** University of Illinois at Chicago  
**Component:** Microphysics Laboratory, Physics Department  
**Address:** P.O. Box 4348  
Chicago, IL 60680  
**Notes:** For 1991 Workshop, "Current Status of Direct Growth of CdTe and HgCdTe on Silicon by MBE"

**Contact Name:** CF Langenhagen  
**Position:** Pres  
**Organization:** Williamson Corporation  
**Component:**  
**Address:** 70 Domino Dr., PO Box 1270  
Concord, MA 01742  
**Notes:** R&D of infrared radiometers for temperature measurement and control.

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**Contact Name:** Y. Lansari  
**Position:**  
**Organization:** North Carolina State University  
**Component:** Department of Physics  
**Address:** 6 Cox Hall, M/S 8202  
Raleigh, NC 27695-8202  
**Notes:** Authored "Integrated Heterostructure Devices Based on II-VI Compound Semiconductors"

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**Contact Name:** Y. Lansari  
**Position:**  
**Organization:** North Carolina State University  
**Component:** Department of Physics  
**Address:** Raleigh, NC 27695-8202  
**Notes:** Authored for 92 MCT workshop "Growth of HgSe and HgCdSe Thin Films by Molecular Beam Epitaxy"  
For 1991 Workshop, authored "Quantum Hall Effect and Setback Modulation Doping in HgTe-CdTe Heterostructures"

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**Contact Name:** Ray Larsen  
**Position:** Director  
**Organization:** Newport Industrial Glass Inc.  
**Component:**  
**Address:** 2044-C Placentia Avenue  
Costa Mesa, CA 92627  
**Notes:** Manufacturer of CdTe, GaAs, germanium, silicon, ZnS, and ZnSe for infrared applications.

**Contact Name:** Gilbert Larson  
**Position:** Pres  
**Organization:** Omnidata International Inc.  
**Component:**  
**Address:** 750 W 200 North, PO Box 3489  
Logan, UT 84321  
**Notes:** Development of environmental and industrial sensors, hardware and software for data collection systems.

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**Contact Name:** D.N. Lazarovici  
**Position:**  
**Organization:** Institute for Atomic Physics  
**Component:**  
**Address:** ROMANIA  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Accurate Method for Neutron Fluence Control Used in Improving Neutron-Transmutation-Doped Silicon Detectors"

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**Contact Name:** AZ Lazzara  
**Position:** Pres  
**Organization:** Scisco Inc  
**Component:**  
**Address:** 6020 Academy, NE PO Box 25446  
Albuquerque, NM 87125  
**Notes:** Optical sensor data reduction, including some IR work.

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**Contact Name:** M.B. Lee  
**Position:**  
**Organization:** Grumman Corporate Research Center  
**Component:**  
**Address:** MS A002-26  
Bethpage, NY 11714  
**Notes:** Co-authored for 1992 MCT workshop, "White Beam X-ray Synchrotron Topography Analysis of CdTe (111)B Substrates and Epilayers"

**Contact Name:** E.Y. Lee  
**Position:**  
**Organization:** Rensselaer Polytechnic Institute  
**Component:** Physics Department and Center for Integrated Electronics  
**Address:** 110 Eight Street  
Troy, NY 12180  
**Notes:** Co-authored for 1992 meeting of SPIE on IRFPAs "Fundamental Studies of Schottky Barrier IR Detectors by Ballistic Electron Emission Microscopy"

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**Contact Name:** David Leech  
**Position:**  
**Organization:** TASC  
**Component:**  
**Address:** 1101 Wilson Boulevard  
Arlington, VA 22209  
**Notes:** Complete study for Air Force on US industrial base for focal plane arrays.

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**Contact Name:** Dick Leftwich  
**Position:** Product Manager, Thermal Imaging Sensors  
**Organization:** Magnavox  
**Component:** Government and Industrial Electronics  
**Address:** 46 Industrial Avenue  
Mahwah, NJ 07430-2206  
**Notes:** infrared materials and equipment for military use.

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**Contact Name:** Richard F. Leftwich  
**Position:** Product Manager, Thermal Imaging Sensors  
**Organization:** Magnavox Electronic Systems Company  
**Component:** Electro-Optical Systems  
**Address:** 46 Industrial Avenue  
Mahwah, NJ 07430-2206  
**Notes:**

**Contact Name:** Robert J. Leonard  
**Position:** Manager, Business Planning  
**Organization:** Eastman Kodak Co.  
**Component:** Government Systems Div.  
**Address:** 1447 St. Paul Street  
Rochester, NY 14653  
**Notes:** IR Detectors work, mostly PtSi.

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**Contact Name:** B.F. Levine  
**Position:**  
**Organization:** AT&T Bell Laboratories  
**Component:**  
**Address:** 600 Mountain Avenue  
Murray Hill, NJ 07974  
**Notes:**

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**Contact Name:** M. Levine  
**Position:** Marketing Manager  
**Organization:** Honeywell, Inc.  
**Component:** Solid State Sensors Group  
**Address:** 830 E. Arapaho Road  
Richardson, TX 75081  
**Notes:** Manufactures IR optoelectronic components and assemblies, fiberoptic components, and modules.

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**Contact Name:** Jay Levy  
**Position:** Communications Director  
**Organization:** Agema IR Systems  
**Component:**  
**Address:** 550 County Avenue  
Secaucus, NJ 07094  
**Notes:** Source of printed information about AGEMA

**Contact Name:** Al Lewis  
**Position:** Mgr  
**Organization:** Raytheon Comp.  
**Component:** Special Microwave Devices Operation  
**Address:** 55 Bearfoot Rd.  
Northboro, MA 01532  
**Notes:** Laser and infrared detectors.

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**Contact Name:** Al Lewis  
**Position:** Mgr  
**Organization:** Raytheon Comp.  
**Component:** Special Microwave Devices Operation  
**Address:** 55 Bearfoot Rd.  
Northboro, MA 01532  
**Notes:** Laser and infrared detectors.

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**Contact Name:** Thomas Lewis  
**Position:** President  
**Organization:** Silicon Detector Corporation  
**Component:**  
**Address:** 1240 Avenida Acaso  
Camarillo, CA 93012-8727  
**Notes:** Manufactures and distributes stock and custom NIR/IR LEDs, InGaAs, and silicon photodetectors for a variety of commercial and military applications. Includes single element, bi-cell, quadrant, multi element arrays, filtered, position sensors, opti hybrids, custom hybrids, opto assmelbics, fiberoptics, etc.

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**Contact Name:** Sheng Li  
**Position:** Dr.  
**Organization:** University of Florida  
**Component:**  
**Address:**  
**Notes:** Working in DARPA Producibiliity program, reported at Program Review Meeting in December 1992 on "Novel Grating Coupled III-V Quantum Well INfrared Photodetectors for FPA Applications"

**Contact Name:** Sheng S. Li  
**Position:**  
**Organization:** University of Florida  
**Component:** Department of Electrical Engineering  
**Address:** Gainesville, FL 32611  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "A Novel Grating Coupled Step-Bound-to-Miniband Transition InGaAs/GaAs/AlGaAs Multiquantum Well Infrared Photodetector"

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**Contact Name:** Karl Lifschitz  
**Position:** Chief Executive  
**Organization:** GFI Advanced Technologies, Inc.  
**Component:**  
**Address:** 112-41 69th Avenue  
Forest Hills, NY 113754  
**Notes:** Manufacture of GaAs, germanium, ZnS, and ZnSe for infrared applications, both commercial and military.

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**Contact Name:** T.T. Lin  
**Position:**  
**Organization:** Auburn University  
**Component:**  
**Address:**  
**Notes:** Co-authored 1988 "Adaptive Welding Using Infrared Sensing Techniques Manufacturing Processes, Machines and Systems"

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**Contact Name:** Jing-Hwa Lin  
**Position:**  
**Organization:** Chung-Shan Institute of Science and Technology  
**Component:**  
**Address:** P.O. Box 90008-8-7, Lung-tan, Tao-Yuan  
REPUBLIC OF CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "A Novel CID Emulator for InSb Array"

**Contact Name:** Hao-Hsiung Lin  
**Position:**  
**Organization:** National Taiwan University  
**Component:** Department of Electrical Engineering  
**Address:** 1, Sec. 4, Roosevelt Road  
Taipei, TAIWAN, 10764, REPUBLIC OF CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "A Novel CID Emulator for InSb Array"

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**Contact Name:** Wang Lingjie  
**Position:**  
**Organization:** Huazhong University of Science and Technology  
**Component:**  
**Address:** Wuhan, Hubei 430074  
REPUBLIC OF CHINA  
**Notes:** Authored for 1992 SPIE IRFPA meeting "Optimum Design Model for the Injection of IRCCD"

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**Contact Name:** Benkt Linnander  
**Position:** Technical Support Director  
**Organization:** AGEMA Infrared Systems  
**Component:**  
**Address:** 550 County Avenue  
Secaucus, N.J. 07094  
**Notes:** Develops specific new applications for individual companies using AGEMA's cameras

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**Contact Name:** Roger Little  
**Position:** President  
**Organization:** Spire Corp  
**Component:**  
**Address:** One Patriots Park  
Bedford, MA 01730  
**Notes:** Photovoltaics, solar cells, compound, semiconductor thin films, and high temperature super conductors. Recently opened a new facility in Oman to produce solar cells. Manufacture of CdTe, GaAs, germanium, and silicon for infrared applications.



**Contact Name:** Chris L. Littler  
**Position:**  
**Organization:** North Texas State University  
**Component:** Department of Physics  
**Address:** Denton, TX  
**Notes:** Authored July 1990 "Two-Photon Absorption Characterization of HgCdTe"

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**Contact Name:** C.L. Littler  
**Position:**  
**Organization:** University of Nort Texas  
**Component:** Department of Physics  
**Address:** Denton, TX 76203  
**Notes:** Co-Authored "Heavily Accumulated Surfaces of MCT Detectors: Theory and Experiment" for 1992 MCT Workshop.  
For 1991 Workshop, "Investigation of Mercury Interstititals in MCT alloys Using Resonant Impact-Ionization Spectroscopy"

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**Contact Name:** Jiy-Chen Liu  
**Position:**  
**Organization:** Chung-Shan Institute of Science and Technology  
**Component:**  
**Address:** P.O. Box 90008-8-7, Lung-tan, Tao-Yuan  
REPUBLIC OF CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "A Novel CID Emulator for InSb Array"

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**Contact Name:** B. Liu  
**Position:**  
**Organization:** University of California, Los Angeles  
**Component:** Department of Chemical Engineering  
**Address:** Los Angeles, CA 90024-1592  
**Notes:** Co-authored for 1991 MCT Workshop "Photoassisted Organometallic VPE on CdTe"

**Contact Name:** Art Lockwood  
**Position:** President  
**Organization:** Amber Engineering  
**Component:**  
**Address:** 5756 Thornwood Drive  
Goleta, CA 93117

**Notes:**

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**Contact Name:** Joseph Longo  
**Position:** VP  
**Organization:** Rockwell International Corporation  
**Component:** Science Center  
**Address:** 1049 Camino Do Rios PO Box 1085  
Thousand Oaks, CA 91358

**Notes:** Basic applied research in electro-optics, including IR systems and equipment.

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**Contact Name:** D. Lorans  
**Position:**  
**Organization:** Societe Anonyme de Telecommunications  
**Component:**  
**Address:** 41, rue Cantagrel  
75631 Paris, Cedex 13 FRANCE

**Notes:** Co-authored for 1992 MCT Workshop "Substrate Issues for Mercury Cadmium Telluride"

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**Contact Name:** Dr Paul Lovoi  
**Position:** Pres  
**Organization:** Inta  
**Component:**  
**Address:** 2281 Calle De Luna  
Santa Clara, CA 95054

**Notes:** 3-D laser based machine vision systems, interest in IR guidance.

**Contact Name:** J.R. Lowney  
**Position:**  
**Organization:** National Institute of Standards and Technology  
**Component:** Semiconductor Electronics Division  
**Address:** Gaithersburg, MD 20899  
**Notes:** Co-Author of "Heavily Accumulated Surfaces of MCT Detectors: Theory and Experiment" for 1992 MCT Workshop.  
For 1991 Workshop, "Investigation of Mercury Interstitials in MCT Alloys Using Resonant Impact-Ionization Spectroscopy"

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**Contact Name:** Ronald Lucier  
**Position:**  
**Organization:** American Risk Management Corp.  
**Component:**  
**Address:** 4807 Rockside Road, Ste 500  
Cleveland, OH 44131  
**Notes:** Active in predictive maintenance regimes, especially with nuclear power plants, as well as infrared non-destructive evaluation.

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**Contact Name:** Bjornar Lund  
**Position:**  
**Organization:** Virginia University  
**Component:** Department of Electrical Engineering  
**Address:** Charlottesville, VA  
**Notes:** Co-authored May 1992 report "Monte Carlo Simulation of Electron Transport in HgCdTe"

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**Contact Name:** H. Luo  
**Position:**  
**Organization:** University of Notre Dame  
**Component:** Department of Physics  
**Address:** Notre Dame, IN 46556  
**Notes:** Co-Author of "Stress Confined in the Barriers of Type-III HgTe/CdTe Superlattices" for 1992 MCT Workshop

**Contact Name:** J.D. Luttmer  
**Position:**  
**Organization:** Texas Instruments  
**Component:** Infrared Devices Laboratory  
**Address:** Dallas, TX 75265  
**Notes:** The Microelectronics Manufacturing Science and Technology Program at TI is developing a generic semiconductor device manufacturing technology for the mid-1990's. Although the program goal is to develop and demonstrate low volume, fast cycle time, cost effective silicon microelectronic manufacturing the technology also is applicable to MCT, Ga As and other materials.

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**Contact Name:** Robert Lyle  
**Position:** Pres  
**Organization:** Exotech, Inc  
**Component:**  
**Address:** 8502 Dakota Dr.  
Gaithersburg, MD 20877  
**Notes:** Electro-optical and electronic instrumentation

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**Contact Name:** Neal A. MacNamara  
**Position:**  
**Organization:** Southern Nuclear Operating Center  
**Component:**  
**Address:** 40 Inverness Center Parkway  
Birmingham, AL 35242  
**Notes:** Active in infrared predictive maintenance, helped purchase their equipment.

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**Contact Name:** J. Mactaggart  
**Position:** VP Marketing  
**Organization:** Hughes Aircraft Company  
**Component:**  
**Address:** 328 Ellen Street  
Midland, Ontario, L4R 2H2, CANADA  
**Notes:** 02/02/90

**Contact Name:** Duncan MacVicar  
**Position:** Consultant, President  
**Organization:** MacVicar Associates  
**Component:**  
**Address:** 1171 Buckingham Drive  
Los Altos, VA 94024  
**Notes:** Offers marketing and management consulting services for domestic and international high technology industry, including electro-optics. No direct IR experience, a one man operation.

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**Contact Name:** Bob Madding  
**Position:**  
**Organization:** McDonnell Douglas Tech Inc.  
**Component:**  
**Address:** 11955 Bajada Road  
San Diego, CA 92128-2023  
**Notes:** Active in infrared remote sensing. He is a respected authority with an overview of the market.

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**Contact Name:** Robert P. Madding  
**Position:**  
**Organization:** McDonnell Douglas Technologies, Inc.  
**Component:**  
**Address:** 11955 Bajada Road  
San Diego, CA 92128-2023  
**Notes:** Active in infrared predictive maintenance, a respected authority on predictive maintenance regimes.

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**Contact Name:** N.L. Madsen  
**Position:**  
**Organization:** Auburn University  
**Component:**  
**Address:**  
**Notes:** Co-authored 1984 "Automatic Welding: Infrared Sensors for Process Control Computer Based Factory Automation"

**Contact Name:** Michael Magers  
**Position:** Dirct  
**Organization:** Bobbit Laboratories  
**Component:** Viggo-Spectramed  
**Address:** 1900 Williams Dr.  
Oxnard, CA 93030  
**Notes:** Instrumentation and precise measurement using advanced systems, including infrared sensors.

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**Contact Name:** DE Maguire  
**Position:** Pres  
**Organization:** Kemet Electronics Corporation  
**Component:**  
**Address:** 2605 Laurens Hwy., PO Box 5928, Greenville, SC 29606  
**Notes:** Applied research and development on passive electronic components.

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**Contact Name:** H. Maier  
**Position:**  
**Organization:** AEG  
**Component:**  
**Address:** D-7100 Heilbronn  
GERMANY  
**Notes:** Co-authored for 1991 MCT Workshop "Influence of Resonant Defect States on Subband Structures in HgCdTe"

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**Contact Name:** E. Maldonado  
**Position:**  
**Organization:** University of Nort Texas  
**Component:** Department of Physics  
**Address:** Denton, TX 76203  
**Notes:** For 1991 Workshop, "Investigation of Mercury Interstititals in MCT alloys Using Resonant Impact-Ionization Spectroscopy"

**Contact Name:** R.G. Mani  
**Position:**  
**Organization:** University of Maryland  
**Component:**  
**Address:** College Park, MD  
**Notes:** Co-authored 1987 study "Magnetophonon Effect in HgCdTe"  
Co-authored 1987 study "Phase Differences Between Quantum Oscillations of the Magnetoresistance and the Hall Effect in HgMnTe and HgCdTe"

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**Contact Name:** John Marchesano  
**Position:** President  
**Organization:** Decilog, Inc.  
**Component:**  
**Address:** 555 Broad Hollow Rd  
Melville, NY 11747-5093  
**Notes:** Technical support to government and industry in infrared systems and components.

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**Contact Name:** Robert P. Marcus  
**Position:** President  
**Organization:** RGB Spectrum  
**Component:**  
**Address:** 950 Marine Village Parkway  
Alameda, CA 94501  
**Notes:** Thermal imaging, predominantly for military applications.

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**Contact Name:** Y. Marfaing  
**Position:**  
**Organization:** CNRS  
**Component:** Laboratoire de Physique des Solides de Bellevue  
**Address:** F-92195 Meudon-Cedex, FRANCE  
**Notes:** Authored for 1991 MCT Workshop "Point Defects and Defect-Purity Interaction of CdHgTe and Other II-VI Semiconductors: Facts and Conjectures."

**Contact Name:** David Marlow  
**Position:** International Marketing Manager  
**Organization:** Marlow Industries, Inc.  
**Component:**  
**Address:** 10451 Vista Park Road  
Dallas, TX 75238  
**Notes:** Manufactures thermoelectric cooling devices, thermoelectric cooling assemblies, and related power supplies and temperature controllers

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**Contact Name:** Philip D. Marlowe  
**Position:** Sales Manager  
**Organization:** Cleveland Crystals, Inc.  
**Component:**  
**Address:** 19306 Redwood Avenue, P.O. Box 17157 Cleveland, OH 44117  
**Notes:** Manufacturer and research into CdTe, ZnS, and ZnSe infrared materials, specialty in II-VI materials. For both military and commercial markets.

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**Contact Name:** Stuart E. Marsh  
**Position:**  
**Organization:** University of Arizona  
**Component:** Arizona Remote Sensing Center  
**Address:** 845 North Park Avenue  
Tucson, AZ 45719  
**Notes:** active in infrared remote sensing

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**Contact Name:** C. Martino  
**Position:** IR Marketing Manager  
**Organization:** Hughes Aircraft Co.  
**Component:**  
**Address:** 2051 Palomar Airport Road  
Carlsbad, CA 92009  
**Notes:**



**Contact Name:** K. Maruyama  
**Position:**  
**Organization:** Georgia Tech Research Institute  
**Component:** Physical Sciences Laboratory  
**Address:** 225 North Avenue, NW  
Atlanta, GA 30332-0800  
**Notes:** Co-authored for 1991 MCT Workshop "Gas Source Iodine Doping and Characterization of MBE Epitaxially Grown CdTe"

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**Contact Name:** Lawrence Matteson  
**Position:** Manager  
**Organization:** Eastman Kodak Company  
**Component:** Kodak Apparatus Division  
**Address:** 901 Elmgrove Rd.  
Rochester, NY 14653  
**Notes:** Applied research in physics and engineering to establish experimental and analytical foundations for new and improved processes in electro, photo-optical, and mechanical products. Additional research with PtSi under a contract from the Air Force Aeronautical Systems Division for use in adverse weather landing systems.

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**Contact Name:** EK Matthews  
**Position:** Pres  
**Organization:** The Pyrometer Instrument Company  
**Component:**  
**Address:** 234 Industrial Pkwy.  
Northvale, NJ 07647  
**Notes:** Design and production of infrared temperature measurement systems.

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**Contact Name:** John-Paul Mattia  
**Position:**  
**Organization:** MIT  
**Component:** Lexington Lincoln Lab  
**Address:** 244 Wood Street  
Lexington, MA 02173-9108  
**Notes:** Co-authored April 1990 study entitled "PtSi Schottky-Barrier Focal Plane Arrays for Multispectral Imaging in Ultraviolet, Visible, and Infrared Spectral Bands"

**Contact Name:** R.B. Mattson  
**Position:**  
**Organization:** MIT  
**Component:** Lexington Lincoln Lab  
**Address:** 244 Wood Street  
Lexington, AM 02173-9108  
**Notes:** Co-authored August 1989 study entitled "128 X 128 Element IrSi Schottky-Barrier Focal Plane Arrays for LWIR Imaging"

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**Contact Name:** Mario Maury  
**Position:**  
**Organization:** Maury Microwave Corp  
**Component:**  
**Address:** 2900 Inland Empire Blv  
Ontario, CA 91764  
**Notes:** Cryogenic equipment for military markets, some commercial.

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**Contact Name:** P.W. Mausel  
**Position:**  
**Organization:** Indiana State University  
**Component:** Department of Geography and Geology  
**Address:** Terre Haute, IN 47809  
**Notes:** Active in infrared remote sensing, has done studies which favored infrared videography over infrared photos; interested in developing the technology.

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**Contact Name:** T. Maxworthy  
**Position:**  
**Organization:** University of California in Los Angeles  
**Component:**  
**Address:**  
**Notes:** Authored February 1991 study, "Laboratory Modelling of the Dynamics of Coastal Upwelling" which studies the dynamics of the filamentary structures that have been repeatedly observed by satellite by IR imagery taken from the West Coast.

**Contact Name:** George A. May  
**Position:**  
**Organization:** ITD - Space Remote Sensing Center  
**Component:**  
**Address:** Building 1103 Suite #118  
Stennis Space Center, Mississippi 39529  
**Notes:** Active in infrared remote sensing, military and commercial.

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**Contact Name:** Alex McCallam  
**Position:** President  
**Organization:** McCallum & Associates, Inc.  
**Component:**  
**Address:** 330 Pearl Street, Suite 3A  
New York, NY 10038  
**Notes:** Represents MediScience, Inc, which funded Alfano's work at CCNY on breast cancer detection. Interests in additional funding. Sees use in cancer pre-diagnosis and cardiology during operations.

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**Contact Name:** Donald E. McClure  
**Position:**  
**Organization:** Brown University  
**Component:** Center for Advanced Materials Research  
**Address:** 182 Hope Street, P.O. Box D  
Providence, RI 02912  
**Notes:** Authored "Image Acquisition and Processing Equipment for Machine Vision" September 1990, distributed by Defense Technical Information Center

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**Contact Name:** William P. McCracken  
**Position:**  
**Organization:** Texas Instruments, Inc.  
**Component:** Image Sensor Technology Center  
**Address:** P.O. Box 650311, Mail Stop 3966  
Dallas, TX 75265  
**Notes:** Involved in electronics imaging, designing advanced video cameras at TI, specifically CCD cameras. Prefers CCDs to conventional IR detectors.

**Contact Name:** Tom McGill  
**Position:** Dr.  
**Organization:** California Institute of Technology  
**Component:**  
**Address:** 1201 East California Boulevard  
Pasadena, CA 91125  
**Notes:** Reported at the DARPA Program Review on Infrared Focal Plane Array Technology in December, 1992, on "InAs/GaInSb Superlattices: Growth Involving Anion Switching"

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**Contact Name:** T.C. McGill  
**Position:**  
**Organization:** California Institute of Technology  
**Component:**  
**Address:** 1201 East California Boulevard  
Pasadena, CA 91125  
**Notes:** Co-Authoerdr "Augur Lifetimes in Ideal InGaSb/InAs Superlattices" for 1992 MCT Workshop.

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**Contact Name:** Peter McGrath  
**Position:** General Manager  
**Organization:** Optoelectronics- Textron  
**Component:**  
**Address:** 1309 Dynamics St. PO Box 750039  
Petaluma, CA 94975-0039  
**Notes:** Manufactures lead salt infrared detectors and related components

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**Contact Name:** Brian McLain  
**Position:** Sales Manager  
**Organization:** Eagle-Picher Industries, Inc.  
**Component:**  
**Address:** P.O.Box 737  
Quapaw, OK 74363  
**Notes:**

**Contact Name:** Gerard McLarhon  
**Position:** CEO  
**Organization:** Applied Solar Energy corporation  
**Component:**  
**Address:** 15251 E Don Julian Rd.  
City of Industry, CA 91749  
**Notes:** Product oriented R&D of solar laser detector products, including CdTe

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**Contact Name:** J.A. McLuckey  
**Position:** President  
**Organization:** Rockwell International Corporation  
**Component:** Defense Electronics  
**Address:** 3370 Miraloma Ave.  
Anaheim, CA 92803  
**Notes:** Electro-optical products and systems, including IR equipment and components.

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**Contact Name:** Phillip C. McMullan  
**Position:**  
**Organization:** TSI Thermo-Scan Energy Management  
**Component:**  
**Address:** 15658 North Gray Road, Box 705  
Carmel, IN 46032  
**Notes:** active in infrared predictive maintenance

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**Contact Name:** Phillip C. McMullan  
**Position:**  
**Organization:** TSI Thermoscan Energy Management  
**Component:**  
**Address:** 15658 North Gray Road, Box 705  
Carmel, IN 46032  
**Notes:** infrared non-destructive evaluation

**Contact Name:** Brett McNeil  
**Position:** Advanced Products Manager  
**Organization:** SBRC  
**Component:**  
**Address:**  
**Notes:** Knows diversification opportunities and Military work at SBRC.

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**Contact Name:** Michael J. McNutt  
**Position:**  
**Organization:** MIT  
**Component:** Lexington Lincoln Lab  
**Address:** 244 Wood Street  
Lexington, AM 02173-9108  
**Notes:** Co-authored August 1989 study entitled "128 X 128 Element IrSi Schottky-Barrier Focal Plane Arrays for LWIR Imaging"

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**Contact Name:** DL McPherson  
**Position:** Gmgr  
**Organization:** General Dynamics Corporation  
**Component:** General Dynamics Air Defense Systems Division  
**Address:** PO Box 50800  
Ontario, CA 91761-1085  
**Notes:** Exploration of new sensor concepts for electro-optical detection, guidance, and measurement applications for military markets.

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**Contact Name:** D.L. McPherson  
**Position:** General Manager  
**Organization:** General Dynamics Corporation  
**Component:** General Dynamics Air Defense Systems Division  
**Address:** PO Box 50800  
Ontario, CA 91761-1085  
**Notes:** Exploration of new sensor concepts for electro-optical detection, guidance, and measurement applications for military markets.

**Contact Name:** Thomas McRae  
**Position:** President and CEO  
**Organization:** Laser Imaging Systems, Inc.  
**Component:**  
**Address:** 204A E. McKenzie  
Punta Gorda, FL 33950  
**Notes:** Has developed MCT-based gas detection cameras used for fugitive gas leaks as well as in factory testing for gas leaks. Marketed through Inframetrics.

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**Contact Name:** P. Meisen  
**Position:**  
**Organization:** Fraunhofer-Institut für Angewandte Festkörperphysik  
**Component:**  
**Address:** D-7800 Freiburg, GERMANY  
**Notes:** Authored "XPD Investigation of Substrate Crystallinity at HgCdTe (111B) and CdTe(111)B Surfaces Upon Ag and Al Overlayer Formation."

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**Contact Name:** Jan Melles  
**Position:** CEO  
**Organization:** Melles Griot  
**Component:**  
**Address:** 1770 Kettering St.  
Irvine, CA 92714  
**Notes:** Research into optical sciences and optical thin films.

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**Contact Name:** Arthur Mengel  
**Position:** Pres  
**Organization:** Teltron, Inc.  
**Component:**  
**Address:** 2 Riga Ln.  
Birdsboro, PA 19508  
**Notes:** Development and production of UV, IR, and TV cameras.

**Contact Name:** Heather Messenger  
**Position:** Senior Editor, Markets  
**Organization:** Laser Focus World  
**Component:**  
**Address:** One Technology Park Drive  
P.O. Box 989  
Westford, MA 01886  
**Notes:** Wrote November 1992 article "Detector Makers Seek Dual-Use Technology for Survival." Friends with David Leech.

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**Contact Name:** Z.Y. Mi  
**Position:**  
**Organization:** Shanghai Institute of Technical Physics  
**Component:** National Laboratory for INfrared Physics  
**Address:** Academia Sinica  
Shanghai 200083  
CHINA  
**Notes:** Co-authored for 1991 MCT Workshop "Influence of Resonant Defect States on Subband Structures in HgCdTe"

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**Contact Name:** Joel Milelli  
**Position:** Gmgr  
**Organization:** Loral Corporation  
**Component:** Loral-Fairchild Imaging Sensors  
**Address:** 1801 McCarthy Blvd.  
Milpitas, CA 95035  
**Notes:** Development of IR sensing systems.

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**Contact Name:** David Miller  
**Position:** Gmgr  
**Organization:** Aritech  
**Component:** Aritech Corporation  
**Address:** 1510 Tate Blvd., SE  
Hickory, NC 28603  
**Notes:** Sensor detector and alarm system equipment.



**Contact Name:** Sol Mirelez  
**Position:** Marketing Communications Manager  
**Organization:** Rosemount Inc.  
**Component:** Aerospace Division  
**Address:** 14300 Judicial Road  
Burnsville, MN 55337

**Notes:**

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**Contact Name:** M.M. Miroshnikov  
**Position:**  
**Organization:** S.I. Vavilov State Optical Institute  
**Component:**  
**Address:** Moscow, RUSSIA  
**Notes:** Authored for 1991 SPIE meeting on Infrared Technology "Infrared in the USSR: Brief Historical Survey of Infrared Development in the Soviet Union"

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**Contact Name:** K.L. Moazed  
**Position:**  
**Organization:** North Carolina State University at Raleigh  
**Component:** Department of Materials Science and Engineering  
**Address:** Raleigh, NC  
**Notes:** Authored June 1980 paper "MBE Growth of HgCdTe"

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**Contact Name:** Jonathan H. Mohler  
**Position:**  
**Organization:** EG & Mound Applied Technology  
**Component:**  
**Address:** Box 3000  
Manisburg, OH 45342  
**Notes:** active in infrared remote sensing

**Contact Name:** S. Mohling  
**Position:**  
**Organization:** Dresden University of Technology  
**Component:** Institut fur Festkorperelektronik  
**Address:** Dresden, FEDERAL REPUBLIC OF GERMANY  
**Notes:** Co-authored for 1992 SPIE IRFPA meeting "Pyroelectric IR Single-Element Detectors and Arrays Based on LiNbO<sub>3</sub> and LiTaO<sub>3</sub>"

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**Contact Name:** S.E. Mohr  
**Position:**  
**Organization:** EG&G Princeton Applied Research  
**Component:**  
**Address:** 375 Phillips Boulevard  
Trenton, NJ 08618  
**Notes:** Co-authored for 1992 SPIE Workshop on IRFPAs "Popcorn Noise in Linear InGaAs Detector Arrays"

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**Contact Name:** Chrsitine Monestier  
**Position:** Advertising Manager  
**Organization:** Litton Electron Devices  
**Component:**  
**Address:** 960 Industrial  
San Carlos, CA 94070  
**Notes:** Infrared systems and equipment, c/o sysctms, night vision for military markets.

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**Contact Name:** John Moore  
**Position:** Business and Marketing Manager  
**Organization:** BSA Technology, Inc.  
**Component:**  
**Address:** 3812 Sepulveda Blvd, Ste 500  
Torrance, CA 90505  
**Notes:** Infrared detectors in 1-14 micrometer range (MCT), HgMnTe, InSb, and others), infarred pyrometers, copper and molybdenum mirrors, laser power and energy measurement systems, crystals operitcal elements, solar energy collection mirrors, etc.

**Contact Name:** James Morgan  
**Position:** President  
**Organization:** Applied Materials, Inc.  
**Component:**  
**Address:** 3050 Bowers Ave.  
Santa Clara, CA 95054  
**Notes:** Research on chemical vapor deposition and plasma etching processes materials and equipment, with particular emphasis on semiconductor materials, metals and dielectrics for the electronics industry, ion implantation of dopants into silicon and process control equipment.

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**Contact Name:** William T. Morgan  
**Position:**  
**Organization:** Infrared Engineering Services  
**Component:**  
**Address:** 110 Shadow Oaks Drive  
Easley, SC 29642  
**Notes:** Infrared non-destructive evaluation firm, doing mostly thermal building surveys.

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**Contact Name:** C.G. Morgan-Pond  
**Position:**  
**Organization:** Wayne State University  
**Component:** Department of Physics  
**Address:** Detroit MI  
**Notes:** Co-authored 1990 "FORMATION MECHANISMS OF INTERSTITIAL DEFECT STATES"  
And 1991 "Present Status and Future of Theoretical Work on Point Defects and Diffusion in Semiconductors"  
And 1990 "Structural Energies of Defects in CdTe and HgCdTe"  
and April 1990 "Point Defects with Lattice Distortion in CdTe and HgCdTe"

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**Contact Name:** Walter Morrow  
**Position:** Deputy Director of Visionics lab  
**Organization:** Army Night Vision Labs  
**Component:**  
**Address:** Fort Belvoir, VA  
**Notes:** Secy: -1760. Wrote "Common Modules: A Success Story" in 1988.

**Contact Name:** Charlie Morse  
**Position:** Pres  
**Organization:** Kistler-Morse Corporation  
**Component:**  
**Address:** 10201 Willows Rd., NE, PO Box 3009, Redmond, WA 98073  
**Notes:** R&D of semiconductor displacement sensors.

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**Contact Name:** David Morton  
**Position:** CEO  
**Organization:** Alcan Aluminum Limited  
**Component:** ManLabs  
**Address:** 21 Erie St.  
Cambridge, MA 02139  
**Notes:** Basic applied and product oriented research in metals, alloys, ceramics, and electro-optical materials.

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**Contact Name:** Asa Morton  
**Position:** Pres  
**Organization:** American Interplex Corporation Laboratories  
**Component:**  
**Address:** 8600 Kanis Rd.  
Little Rock, AR 72204  
**Notes:** R&D on thermal properties of various metals and metal coatings; research in infrared spectroscopy and monitoring using infrared technologies.

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**Contact Name:** S. Motakef  
**Position:**  
**Organization:** MIT  
**Component:**  
**Address:** Cambridge, MA 01742  
**Notes:** Co-authored "Long Wavelength HgMnTe Avalanche Photodiodes" for 1991 MCT Workshop.

**Contact Name:** Paul Mullen  
**Position:** Manager  
**Organization:** Laser Diode Inc.  
**Component:**  
**Address:** 205 Forrest Street  
Metuchen, NJ 08840-1292  
**Notes:** Manufacturer of GaAs and germanium materials for infrared applications.

---

**Contact Name:** Jimmy Murphy  
**Position:** Program Manager, Integrated Blade Inspection Systems  
**Organization:** General Electric Co.  
**Component:** General Electric Aircraft Engines  
**Address:** 1 Neumann Way, P.O. Box 156301  
Cincinnati, OH 45215-6301  
**Notes:** Helped design GEAE's thermographic inspection equipment for non-destructive evaluation of jet engine parts, originally from Air Force funding

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**Contact Name:** James C. Murphy  
**Position:**  
**Organization:** Johns Hopkins University  
**Component:** Center for NDE and Applied Physics Laboratory  
**Address:** Laurel, MD 20723  
**Notes:** Infrared non-destructive evaluation of advanced materials, leading researcher.

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**Contact Name:** Thomas H. Myers  
**Position:** Physics Department  
**Organization:** West Virginia University  
**Component:**  
**Address:** P.O. Box 6315  
Morgantown, WV 26506-6315  
**Notes:** Attended 1992 MCT Workshop

**Contact Name:** Charles W. Myles  
**Position:**  
**Organization:** Texas Tech University  
**Component:** Department of Physics and Engineering Physics  
**Address:** Lubbock, TX 79409-1051  
**Notes:** Co-authored for 1991 MCT workshop "Critical Stress of HgCdTe Solid Solutions." and "Microhardness of Hg-Containing II-VI Alloys"

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**Contact Name:** S. Nagarajan  
**Position:**  
**Organization:** Auburn University  
**Component:**  
**Address:**  
**Notes:** Co-authored 1991 "Weld Quality Control in Gas Tungsten Arc Welding Process"

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**Contact Name:** Albert Narath  
**Position:** President  
**Organization:** American Telephone and Telegraph  
**Component:** Sandia National Laboratories  
**Address:** Albuquerque, NM 87185-5800  
**Notes:** Basic and applied research for US DoE in solid state materials, science, physics, opto-electronics, aerospace sciences, solar, geothermal, fossil, fission and fusion energy.

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**Contact Name:** Albert Narath  
**Position:** Pres  
**Organization:** American Telephone and Telegraph Co.,  
**Component:** Sandia National Laboratories  
**Address:** Albuquerque, NM 87185-5800  
**Notes:** Basic and applied research for US DoE in solid state materials, science, physics, opto-electronics, aerospace sciences, solar, geothermal, fossil, fission and fusion energy.

**Contact Name:** Ram M. Narayanan  
**Position:**  
**Organization:** University of Nebraska  
**Component:** Center for Electro-Optics  
**Address:** Lincoln, NE 69588  
**Notes:** active in infrared remote sensing

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**Contact Name:** Donald Neamen  
**Position:**  
**Organization:** University of New Mexico  
**Component:** Department of Electrical and Computer Engineering  
**Address:** Albuquerque, NM 87131  
**Notes:** Co-authored with Eustace Dereniak for 1992 SPIE IRFPA meeting "Computer Simulation of a Switched FET Readout Multiplexer"

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**Contact Name:** J.G. Needham  
**Position:** General Manager  
**Organization:** MCP Wafer Technology  
**Component:**  
**Address:** Unit 34, Maryland Road, Tongwell, Milton Keynes, Bucks, MK158HJ  
UNITED KINGDOM  
**Notes:** Production of CdTe and GaAs for infrared applications.

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**Contact Name:** Jeannette Neff  
**Position:** Mgr. Marketing Communications  
**Organization:** Kollsman Division of Sequa Corp.  
**Component:**  
**Address:** 220 Daniel Webster Highway  
Merrimack, NH 03054  
**Notes:** E/O Systems, infrared systems and equipment, night vision for military.

**Contact Name:** Dr John Nelson  
**Position:** VP  
**Organization:** Baker Hughes, Inc.  
**Component:** TN Technology, Inc.  
**Address:** PO Box 800, Round Rock  
TX 78680-0800  
**Notes:** Applied R&D of radiation detectors and sources, acoustical transducers, and measurements and data processing methodology directed toward the development of instrumentation for the measurement of industrial process parameters.

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**Contact Name:** Craig R. Nelson  
**Position:** VP for New Business Development  
**Organization:** Emcore Corp.  
**Component:**  
**Address:** 35 Elizabeth Avenue  
Somerset, NJ 08873  
**Notes:** Material production of GaAs, CdTe, silicon, ZnS, and ZnSe for infrared applications.

---

**Contact Name:** John Nelson  
**Position:** Marketing Manager  
**Organization:** Marlow Industries, Inc.  
**Component:**  
**Address:** 10451 Vista Park Road  
Dallas, TX 75238  
**Notes:** Manufactures thermoelectric cooling devices, thermoelectric cooling assemblies, and related power supplies and temperature controllers

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**Contact Name:** Ralph Nelson  
**Position:** Dr.  
**Organization:** Univ of Illinois College of Medicine  
**Component:** Carle Foundation  
**Address:** 611 West Park Street  
Urbana, IL 61801  
**Notes:** active in infrared biomedical thermography



**Contact Name:** D.A. Nelson  
**Position:**  
**Organization:** University of Maryland  
**Component:**  
**Address:** College Park, MD  
**Notes:** Co-authored 1987 study "Magnetophonon Effect in HgCdTe"

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**Contact Name:** Y. Nemirovsky  
**Position:**  
**Organization:** Kidron Microelectronics Research Center  
**Component:** Department of Electrical Engineering  
**Address:** Technion-Israel Institute of Technology  
Haifa 32000, ISRAEL  
**Notes:** "UV Photon Assisted Control of Interface Charge Between CdTe Substrates and Metal Organic Chemical Vapor Deposition CdTe Epilayers" for 1992 MCT Workshop.  
For 1991 Workshop, co-authored "Tunneling and 1/f Noise Currents in HgCdTe Photodiodes"

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**Contact Name:** Yael Nemirovsky  
**Position:** IIT Department of Electrical Engineering  
**Organization:** Technion University  
**Component:**  
**Address:** Technion City  
Haifa, Israel 3200  
**Notes:** Attended 1992 MCT Workshop

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**Contact Name:** Brett Nener  
**Position:**  
**Organization:** University of Western Australia  
**Component:** Department of Electrical Engineering  
**Address:** Nedlands, Perth, Western Australia 6009  
**Notes:** Attended 1992 MCT Workshop

**Contact Name:** N. Neumann  
**Position:**  
**Organization:** Dresden University of Technology  
**Component:** Institut für Festkörperelektronik  
**Address:** Dresden, FEDERAL REPUBLIC OF GERMANY  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Pyroelectric Linear Array IR Detectors with CCD Multiplexer"

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**Contact Name:** Robert Ngyen  
**Position:** COO  
**Organization:** Entec  
**Component:**  
**Address:** Suite 100, 2817 Garden Hwy  
Sacramento, CA 95833  
**Notes:** Basic research in photovoltaics

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**Contact Name:** Yongping Ni  
**Position:**  
**Organization:** Luoyang Optic-Electronic Institute  
**Component:**  
**Address:** P.O. Box 030-12, 471009, Luoyang, Henan, P.R. CHINA  
**Notes:** Authored for 1992 SPIE meeting on IRFPAs "Auto-Gain-Control Characteristics of InSb P+/N Diode with High Sheet Resistance"

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**Contact Name:** Guy M. Nicoletti  
**Position:**  
**Organization:** University of Pittsburgh at Greensburg  
**Component:**  
**Address:**  
**Notes:** Authored 1988 "Optoelectronic Proximity Sensors for Automated Deburring"

**Contact Name:** JA Noll  
**Position:** CEO  
**Organization:** JA Noll Co.,  
**Component:**  
**Address:** PO Box 312  
Monroeville, PA 15146  
**Notes:** Research in optical metrology, some using IR detectors.

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**Contact Name:** P.W. Norton  
**Position:**  
**Organization:** Loral Infrared and Imaging  
**Component:**  
**Address:** 2 Forbes Road MS/146  
Lexington, MA 02173  
**Notes:** Their "guru" on IR detectors, senior scientist.

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**Contact Name:** Paul Norton  
**Position:**  
**Organization:** SBRC  
**Component:**  
**Address:** 75 Coromar Drive  
Goleta, CA 93117  
**Notes:** A leading figure in MCT arrays, esp. IRFPAs.

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**Contact Name:** P.R. Norton  
**Position:**  
**Organization:** Virginia Polytechnic Institute  
**Component:**  
**Address:**  
**Notes:** On Program Committee of 1992 MCT Workshop.  
On Program Committee of 1991 MCT Workshop, as a representative of SBRC.

**Contact Name:** Brian O'Donahue  
**Position:** President  
**Organization:** Inframetrics, Inc.  
**Component:**  
**Address:** 16 Esquire Rd.  
North Billerica, MA 01862  
**Notes:** Infrared imaging radiometers and night vision devices.

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**Contact Name:** Tom O'Neill  
**Position:** CEO  
**Organization:** Pilkington Optronics  
**Component:**  
**Address:** Caxton Street  
Anniesland, Glasgow GL13 1HZ  
**Notes:** Thermal imaging and surveillance systems, laser rangefinders, etc. visible and IR optical systems. Producer of HgCdTe-based FPSs for a variety of military systems, including theIRST on the EFA.

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**Contact Name:** Jasen Ocho  
**Position:** Dr.  
**Organization:** Good Samaritan Hospital & Medical Center  
**Component:** Dept of Neurology  
**Address:** 1015 NW 22nd Avenue  
Portland, OR 97210  
**Notes:** Cctive in infrared biomedical thermography for neurology.

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**Contact Name:** Greg Olsen  
**Position:**  
**Organization:** Sensors Unlimited, Inc.  
**Component:**  
**Address:** Princeton, NJ  
**Notes:** Start up company founded by former persident and CEO of EPITAXX, Inc., to advance recent developments in III-V compound device tech fro sensing and imaging applications in the 1000-3000 nm near-infrared spectrym. Ongoing development projects include a monolithic InGaAs detector for NASA Jet Propulsion Labs and 2000-5000 DFB lasers for Kirtland Air Force Base Phillips Lab.

**Contact Name:** Dr MW Overhoof PhD  
**Position:** Pres  
**Organization:** Overhoff Technologies Corporation  
**Component:**  
**Address:** 1160 US RT 50, PO Box 182  
Millford, OH 45150  
**Notes:** Design and development and manufacture of electronic instrumentation and sensor systems for measurement and control, including infrared, other optical, ultraviolet and nuclear, gaging.

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**Contact Name:** Tofie Owen  
**Position:** V.P. Marketing  
**Organization:** Magnavox Electronic Systems, Inc.  
**Component:**  
**Address:** 1313 Production Road  
Fort Wayne, IN 46808  
**Notes:** /o systems, infrared systems and equipment, night vision for military markets.

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**Contact Name:** James Owlswey  
**Position:** VP  
**Organization:** Northrop Corporation  
**Component:** Rolling Meadows Site  
**Address:** 600 Hicks Rd.  
Rolling Meadows, IL 60008  
**Notes:** Development of electronic and infrared detection systems for military.

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**Contact Name:** Carol L. Oxley  
**Position:** President  
**Organization:** Target Corp.  
**Component:**  
**Address:** 8400 Lakeview Parkway, Suite 200  
Kenosha, WI 53142-7404  
**Notes:** infrared systems and equipment, passive and active c/o devices

**Contact Name:** Paul Page  
**Position:** Mgr  
**Organization:** Sensor Control Corporation  
**Component:** Gentran  
**Address:** 49050 Milmont Dr.  
Fremont, CA 94538  
**Notes:** Research on infrared temperature measurements.

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**Contact Name:** G.N. Pain  
**Position:**  
**Organization:** EPI Crystal Supplies Pty, Ltd.  
**Component:**  
**Address:** Monbulk, Victoria, 3793 Australia  
**Notes:** Authored for 1991 MCT Workshop "Effects of mixed-valence Mercury and Indium on the Electrical Properties of HgCdTe"

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**Contact Name:** H.D. Palfrey  
**Position:**  
**Organization:** University of Southampton  
**Component:** Engineering Materials  
**Address:** Southampton, SO9 5NH  
UNITED KINGDOM  
**Notes:** Authored "Growth Method, Composition, and Defect Structure Dependence of Mercury Diffusion in CdHgTe" for 1992 MCT Workshop.

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**Contact Name:** Yen-Ming Pann  
**Position:**  
**Organization:** Chung-Shan Institute of Science and Technology  
**Component:**  
**Address:** P.O. Box 90008-8-7, Lung-tan, Tao-Yuan  
REPUBLIC OF CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "A Novel CID Emulator for InSb Array"

**Contact Name:** Prauin Parekh  
**Position:** Director  
**Organization:** Honeywell, Inc.  
**Component:** Solid State Electronics Center  
**Address:** 12001 State Hwy 55  
Plymouth, MN 55441-2080  
**Notes:** Research, engineering and manufacturing of microunits, sensors, transducers and advanced packaging.

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**Contact Name:** Dr Prauin Parekh  
**Position:** Dir  
**Organization:** Honeywell, Inc.  
**Component:** Solid State Electronics Center  
**Address:** 12001 State Hwy 55  
Plymouth, MN 55441-2080  
**Notes:** Research, engineering and manufacturing of microunits, sensors, transducers and advanced packaging.

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**Contact Name:** Joseph A. Parini  
**Position:** President  
**Organization:** Elbit Systems, Inc.  
**Component:**  
**Address:** 16 Esquire Road  
North Billerica, MA 01862  
**Notes:** EO systems, infrared systems and equipment, night vision for military markets

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**Contact Name:** Camillo Pariset  
**Position:** P.R. Manager  
**Organization:** Elettronica S.p.A.  
**Component:**  
**Address:** via Tiburtina KM 13.7  
I-00131 Rome, ITALY  
**Notes:** Infrared systems and equipment for European military market.

**Contact Name:** Mann J. Park  
**Position:**  
**Organization:** Korea University  
**Component:** Sung-Buk-Ku  
**Address:** Cong-Am-Dong  
Seoul, KOREA 136-701  
**Notes:** Attended 1991 MCT Workshop, materials research.

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**Contact Name:** Nancy Parker  
**Position:** Business Communications  
**Organization:** Textron Defense Systems  
**Component:**  
**Address:** 201 Lowell Street  
Wilmington, MA 01887  
**Notes:** Infrared systems and equipment, GaAs arrays, active and passive c/o systems, detectors and sensors

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**Contact Name:** Ed Patton  
**Position:** COO  
**Organization:** Infrared Industries  
**Component:**  
**Address:** 12151 Research Pkwy  
Orlando, FL 32826  
**Notes:** Lead sulphide, lead selenide, indium antimonide and silicon infrared detectors and thin film optical filters for government and industrial applications; hybrid preamplifier microcircuits.

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**Contact Name:** Alfred P. Pavot  
**Position:** Dr.  
**Organization:** Greater SE Community Hospital & Georgetown Univ School of Medicine  
**Component:** Dept of PMR  
**Address:** 1310 Southern Avenue, SE  
Washington, DC 20032  
**Notes:** Active in infrared biomedical thermography community as both user and former president of the American Academy of Thermology.



**Contact Name:** M. Pepper  
**Position:**  
**Organization:** Cambridge University  
**Component:** Cavendish Lab  
**Address:** Cambridge, UNITED KINGDOM  
**Notes:** Co-authored October 1988 "MBE of HgCdTe"

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**Contact Name:** F.S. Perry  
**Position:** President  
**Organization:** Boston Electronics Corp.  
**Component:**  
**Address:** 72 Kent Street  
Brookline, MA 02146  
**Notes:** Manufacture and use of germanium and silicon. Handles laser and optoelectronic detectors and accessories, fiberoptic components and equipment, optics, optoelectronic devices, materials and substrates, etc.

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**Contact Name:** Ron Perry  
**Position:** Dir. Sales and Marketing  
**Organization:** Pulse Instruments  
**Component:**  
**Address:** 1234 Francisco Street  
Torrance, CA 90502  
**Notes:** E/o systems, infrared systems & equipment for military applications.

---

**Contact Name:** David L. Perry  
**Position:**  
**Organization:** University of Arizona  
**Component:** Optical Sciences Center  
**Address:** Tucson, AZ 85721  
**Notes:** Author in 1992 SPIE meeting of "Measured Performance of the Hughes 256X256 Hybrid PtSi Imaging Device"

**Contact Name:** R.E. Peterson  
**Position:** Vice President  
**Organization:** Honeywell, Inc.  
**Component:** Systems & Research Center  
**Address:** 3660 Technology Dr.  
Minneapolis, MN 55418  
**Notes:** Development of electro-optical materials and sensors mainly for military;  
developing commercial opportunities.

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**Contact Name:** Thomas Petry  
**Position:** CEO  
**Organization:** Eagle-Picher Industries, Inc.  
**Component:** Eagle-Picher Research Laboratory  
**Address:** 200 Ninth Ave., NE  
Miami OK 74354-3305  
**Notes:** Crystals for IR or UV detectors.

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**Contact Name:** Fletcher Phillips  
**Position:** President  
**Organization:** General Motors, Corporation  
**Component:** Santa Barbara Research Center  
**Address:** 75 Coromar Dr.  
Goleta, CA 93117  
**Notes:** Manufacture of infrared photodetectors and associated components, packages  
and infrared focal plane arrays; electro-optical instrumentation for space;  
particularly multispectral earth observation sensors and weather sensors;  
specialized military equipment such as vehicle fire sensors and missile proximity  
fuses.

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**Contact Name:** F.R. Phillips  
**Position:** President  
**Organization:** Hughes  
**Component:** Santa Barbara Research Center  
**Address:** 75 Coromar Drive  
Goleta, CA 93117  
**Notes:** Heavily involved in a broad array of US military programs using PtSi, HgCdTe,  
and InSb.

**Contact Name:** Jim Phillips  
**Position:** Marketing Director  
**Organization:** SBRC  
**Component:**  
**Address:** 75 Coromar Drive  
Goleta, CA 93117  
**Notes:** Their INFRARED PRODUCTS marketing director.

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**Contact Name:** J.A. Pickup  
**Position:** Sales Admin. Manager  
**Organization:** Oxley Developments Co., Ltd.  
**Component:**  
**Address:** Priory Park  
Ulverston  
Cumbria, UK LA12 9QG  
**Notes:** Detectors and sensors, infrared systems and equipment for military applications.

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**Contact Name:** Lars L. Pierce  
**Position:**  
**Organization:** University of Montana  
**Component:** School of Forestry  
**Address:** Missoula, MT 59812  
**Notes:** active in infrared remote sensing

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**Contact Name:** Michele Pimpinelli  
**Position:** Marketing  
**Organization:** Officine Galileo  
**Component:**  
**Address:** V.A. Einstein 35  
50013 Campi Bisenzio, Florence  
ITALY  
**Notes:** Night vision, thermal imaging, infrared systems & equipment for military applications.

**Contact Name:** Joseph Plonski  
**Position:** V.P. Sales and Marketing  
**Organization:** Imagraph Corp.  
**Component:**  
**Address:** 11 Elizabeth Drive  
Chelmsford, MA 01824  
**Notes:** Thermal imaging, primarily for military market.

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**Contact Name:** Maksymilian Pluta  
**Position:**  
**Organization:** Institute of Applied Optics  
**Component:**  
**Address:** ul. Kamionkowska 18  
03-805 Warszawa, POLAND  
**Notes:** Will be editing the May 1994 edition of Optical Engineering, focusing on Semiconductor Infrared Detectors.

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**Contact Name:** Ruben Pochaczewsky  
**Position:** Dr.  
**Organization:** Albert Einstein College of Medecine  
**Component:** Dept of Radiology  
**Address:** 1300 Morris Park Avenue  
New York, NY 10461  
**Notes:** Professor and doctor active in infrared biomedical thermography community

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**Contact Name:** Leslie G. Polgar  
**Position:** Vice President  
**Organization:** Bertram Laboratories, Inc.  
**Component:**  
**Address:** 72 Readington Road  
Somerville, NJ 08876  
**Notes:** Manufactures GaAs single and polycrystalline ingots and wafers. Applications for diode lasers, LED's, detectors, solar cells, source material for liquid phase epitaxy, IR blanks and modulators.

**Contact Name:** Fred H. Pollak  
**Position:** Dr.  
**Organization:** Brooklyn College  
**Component:** Semiconductor Institute  
**Address:** Brooklyn, NY  
**Notes:** Former director of the SPIE

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**Contact Name:** John Pomeroy  
**Position:** Pres  
**Organization:** Dover Corporation  
**Component:** Universal Instrument Corp.  
**Address:** PO Box 825  
Binghamton, NY 13902  
**Notes:** Automation of electronics industry production.

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**Contact Name:** Gary Powell  
**Position:** Dreng  
**Organization:** Brunson Instrument Co, Inc  
**Component:**  
**Address:** 800 E 23rd PO Box 7951  
Kansas City, MO 64129  
**Notes:** Research, design, and development in the optical mechanical and electro-optical field, circular and linear developing.

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**Contact Name:** Mark Preis  
**Position:**  
**Organization:** Litton Electron Devices Division  
**Component:**  
**Address:** Tempe, AZ 85281  
**Notes:** Spent 22 years at SBRC, doing Lead Salts, InSb, IrSi, and MCT. At litton, doing Lead Salts for commercial applications, thinks will corner 3-5 micron range. Extensive contacts at SBRC, which he left in 1986.

**Contact Name:** Nelson F. Principio  
**Position:** Manager of Business Development  
**Organization:** Eastman Kodak Co.  
**Component:** Government Systems Div.  
**Address:** 1447 St. Paul Street  
Rochester, NY 14653  
**Notes:** IR Detectors work, mostly PtSi.

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**Contact Name:** Theodore Prophet  
**Position:** Gmgr  
**Organization:** Anacon Corp.  
**Component:**  
**Address:** 117 S St.  
Hopkinton, MA 01748  
**Notes:** Applied research on refractometers; chlorine monitors; stack gas monitors;  
ultra-violet and infrared analyzers

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**Contact Name:** N. Pundak  
**Position:**  
**Organization:** RICOR Ltd.  
**Component:**  
**Address:** En Haros (IHU)  
18960  
Israel  
**Notes:** Authored for 1992 SPIE IRFPA workshop "Miniature Closed Cycle Cooler for  
FPA Detectors"

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**Contact Name:** Ernie Pusey  
**Position:** Mkt. Dir.  
**Organization:** Plessey Semiconductors Ltd.  
**Component:**  
**Address:** Unit 1, Crompton Road  
Groundwell Ind. Estate, Seindon, Wilts SN2 5AY  
UNITED KINGDOM  
**Notes:** Manufacture of a wide variety of HgCdTe-based infrared systems for military  
applications.

**Contact Name:** Roger Putnam  
**Position:** Director of Marketing  
**Organization:** Aerodyne Research, Inc.  
**Component:**  
**Address:** 45 Manning Rd.  
Billerica, MA 01821-3976  
**Notes:** Basic and applied product-oriented research in electro-optical and photo-optical systems, combustions, atmospheric, and environmental science; molecular physics; laser development; spectroscopy; product surface chemistry; optical signal processing; optical computing.

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**Contact Name:** Abdelrahman Rabie  
**Position:**  
**Organization:** SUNY College of Technology  
**Component:**  
**Address:**  
**Notes:** AUthored 1983 "The Use of Sensors in Part Handling" available from S.M.E.

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**Contact Name:** David Radford  
**Position:** Marketing Director  
**Organization:** Chemring, Ltd.  
**Component:**  
**Address:** Alchem Works  
Fratton Trading Estate  
Portsmouth, Hampshire, ENGLAND PO4 8SX  
**Notes:** Infrared Systems & Equipment, passive EO systems for military.

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**Contact Name:** D. Rajavel  
**Position:**  
**Organization:** Georgia Tech Research Institute  
**Component:** Physical Sciences Laboratory  
**Address:** 225 North Avenue, NW  
Atlanta, GA 30332-0800  
**Notes:** Co-authored for 1991 MCT Workshop "Gas Source Iodine Doping and Characterization of MBE Grown CdTe"

**Contact Name:** L.R. Ram-Mohan  
**Position:**  
**Organization:** MIT  
**Component:** Electronics Research Lab  
**Address:** 77 Massachusetts Avenue  
Cambridge, MA 02139  
**Notes:** Co-authored January 1987 "Infrared Nonlinear Optics"

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**Contact Name:** L.R. Ram-Mohan  
**Position:**  
**Organization:** Worcester Polytechnic Institute  
**Component:** Department of Physics  
**Address:** Worcester, MA 01609  
**Notes:** Co-Author "States Confined in the Barriers of Type-III HgTe/CdTe Superlattices" for 1992 MCT Workshop

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**Contact Name:** A.C. Ramamurthy  
**Position:**  
**Organization:** BASF Corporation  
**Component:** Coatings Technical Center  
**Address:** 26701 Telegraph Road  
Southfield, MI  
**Notes:** Designing IR inspection system to nondestructively inspect automotive paint for delaminations or rust

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**Contact Name:** Tom Ramey  
**Position:** President  
**Organization:** Ramey Aerospace  
**Component:**  
**Address:** Box 39  
Carmel, CA 93924  
**Notes:** Thermal Imaging, Infrared systems & equipment for military applications.



**Contact Name:** Albert Rand  
**Position:** Pres  
**Organization:** Dynamics Research Corporation  
**Component:**  
**Address:** 60 Concord St.  
Wilmington, MA 01887  
**Notes:** Design and fabrication of optical digital shaft angle encoders for aerospace and industrial applications.

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**Contact Name:** Roderick R. Randolph  
**Position:** Sales Manager  
**Organization:** Exotic Materials, Inc,  
**Component:**  
**Address:** 2930 Bristol St.  
Costa Mesa, CA 92626  
**Notes:** Applied, product-oriented research as related to electro-optical materials, vacuum deposited coatings and devices for government, industrial and military systems applications.

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**Contact Name:** Vithal R. Rao  
**Position:**  
**Organization:** Rensselaer Polytechnic Institute  
**Component:**  
**Address:** JEC 6012  
Troy, NY 12180  
**Notes:** Attended 1992 MCT meeting

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**Contact Name:** D. Rasmussen  
**Position:** Sales Manager  
**Organization:** Honeywell, Inc.  
**Component:** Solid State Sensors Group  
**Address:** 830 E. Arapaho Road  
Richardson, TX 75081  
**Notes:** Manufactures IR optoelectronic components and assemblies, fiberoptic components, and modules.

**Contact Name:** J.P. Rasquin  
**Position:** Directeur Departement de Defense  
**Organization:** Alcatel Bell-SDT S.A.  
**Component:**  
**Address:** 101, rue Chapelle Beaussart  
6032 Mont-Sur-Marchienne BELGIUM  
**Notes:** Infrared Systems and Equipment for military

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**Contact Name:** N.M. Ravindra  
**Position:**  
**Organization:** New Jersey Institute of Technology  
**Component:**  
**Address:** Newark, NJ 07102  
**Notes:** Authored for 1992 SPIE meeting on IRFPAs "HgCdTe Photovoltaic Detectors and Some Related Aspects"

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**Contact Name:** Rikki Razdan  
**Position:** Marketing Manager  
**Organization:** Iscan, Inc.  
**Component:**  
**Address:** 125 Cambridgepark Drive  
Cambridge, MA 02140  
**Notes:** Infrared systems and equipment, e/o systems for military applications.

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**Contact Name:** Manijeh Razeghi  
**Position:** Dr.  
**Organization:** Northwestern University  
**Component:**  
**Address:**  
**Notes:** Presented at December 1992 DARPA IRFPA Technology Program Reviews on "Physics and Performance of GaInP/GaAs Quantum Wells and New Infrared III-V Compound InTISb"

**Contact Name:** CZ Razi  
**Position:** Pres Dr CZ  
**Organization:** Litton Industries, Inc.  
**Component:** Integrated Automation Division  
**Address:** 1301 Harbor Bay Pkwy  
Alameda, CA 94501  
**Notes:** Systems use advanced sensor techniques including vision, ultraviolet, infrared, and x-ray.

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**Contact Name:** JB Reagan  
**Position:** General Manager  
**Organization:** Lockheed Corporation  
**Component:** Lockheed Palo Alto Research Laboratories  
**Address:** 3251 Hanover St., Orgn 90-01  
Palo Alto, CA 94304  
**Notes:** Research and development of electro-optic systems, including HgCdTe under DARPA's Electronic Sciences program.

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**Contact Name:** Herman Recdy  
**Position:** Chief Engineer  
**Organization:** II-VI Inc.  
**Component:**  
**Address:** 375 Saxonburg Blvd  
Saxonburg, PA 16056  
**Notes:** Manufacture of CdTe, GaAs, germanium, silicon, ZnS, ZnSe for infrared applications.

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**Contact Name:** Dr Leon Reibman  
**Position:** CEO  
**Organization:** American Electronic Laboratories, Inc.  
**Component:**  
**Address:** 305 Richardson Rd., PO Box 552  
Landsdale, PA 19446  
**Notes:** Diversified R&D and manufacturing organization specializing in state-of-the-art equipment for military and industrial applications, electronic warfare and electronic warfare support measure systems, radar and fire control, antennas, supplies, technical service, system engineering services and manufacturing services.

**Contact Name:** Kevin Reily  
**Position:** V.P. of IR Detector Group  
**Organization:** SBRC  
**Component:**  
**Address:** 75 Coromar Drive  
Goleta, CA 93117  
**Notes:**

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**Contact Name:** M.B. Reine  
**Position:**  
**Organization:** Loral Corporation  
**Component:** Loral Infrared & Imaging Systems, Inc.  
**Address:** 2 Forbes Rd.  
Lexington, MA 02173  
**Notes:** Leading figure in their producibility efforts, has represented LIIS at IRMP consortium.

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**Contact Name:** Paul Reising  
**Position:**  
**Organization:** Geonex Verde Technologies  
**Component:**  
**Address:** 734 E. Lake Avenue  
Watsonville, CA 95076  
**Notes:** Active in infrared remote sensing as a consulting firm.

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**Contact Name:** J. Ren  
**Position:**  
**Organization:** North Carolina State University  
**Component:** Department of Physics  
**Address:** Raleigh, NC 27695-8202  
**Notes:** AUthored "Integrated Heterostructure Devices Based on II-VI Compound Semiconductors"

**Contact Name:** Frank Renda  
**Position:**  
**Organization:** SBRC  
**Component:**  
**Address:** 75 Coromar Drive  
Goleta, CA 93117  
**Notes:**

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**Contact Name:** Richard A. Reynolds  
**Position:** Dr.  
**Organization:** Hughes Research Laboratories  
**Component:**  
**Address:** 3011 Malibu Canyon Road  
Malibu, CA 90265  
**Notes:** Former DARPA program officer who contributed extensively to II-VI semiconductor development while at the Defense Sciences office.

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**Contact Name:** Herbert Richardson  
**Position:** Dir  
**Organization:** Texas Engineering Experiment Station  
**Component:**  
**Address:** 301 Wisenbaker Engineering Research Center, Texas A&M University, College Station, TX 77843-3126  
**Notes:** Research into all areas of engineering, including introduction of emerging technologies.

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**Contact Name:** H.J. Richter  
**Position:**  
**Organization:** Fraunhofer-Institut für Angewandte Festkörperphysik  
**Component:**  
**Address:** D-7800 Freiburg, GERMANY  
**Notes:** Authored "XPD Investigation of Substrate Crystallinity at HgCdTe (111B) and CdTe(111)B Surfaces Upon Ag and Al Overlayer Formation."

**Contact Name:** Max Riedl  
**Position:** CEO  
**Organization:** Contraves USA  
**Component:** Boston Electro Optic Division  
**Address:** 170 Locke Dr.  
Marlborough, MA 01752  
**Notes:** Applied research on electrical-optical systems, instruments and components utilizing infrared, visible and ultraviolet spectrums, including infrared detectors, optical elements, and optical interference and coatings filters, radiation sources, radiometers, combustion analyzers, navigation instruments for satellites and spacecraft and sensors for meteorological satellites; chemical and drug detection, instrumentation, target and scene simulation, models, gas detection, measurement instrumentation.

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**Contact Name:** George A. Riggs  
**Position:**  
**Organization:** University of Montana  
**Component:** School of Forestry  
**Address:** Missoula, MT 59812  
**Notes:** active in infrared remote sensing

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**Contact Name:** Edward R.J. Ring  
**Position:** Dr.  
**Organization:** Royal National Hospital for Rheumatic Diseases  
**Component:** Dept of Clinical Measurement  
**Address:** Upper Borough Walls, Bath  
UNITED KINGDOM  
**Notes:** Active in infrared biomedical thermography, has written extensively on the widespread applications of IR thermography.

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**Contact Name:** Sherman Rinkel  
**Position:** Pres  
**Organization:** General Microwave Corp.  
**Component:**  
**Address:** 5500 New Horizon Blvd  
Amityville, NY, 11701  
**Notes:** Applied sensor technology for industrial and automotive applications.

**Contact Name:** Dr. Malcom Roberts  
**Position:** Dirres  
**Organization:** Bethlehem Steel Corporation  
**Component:** Homer Research Laboratories  
**Address:** 701 East Third Street  
Bethlehem, PA 18016-7699  
**Notes:** Investigation on new methods of measurement and instrumentation used in the control of steel processes and product quality. Thermal analysis of fatigue and fracture of steel.

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**Contact Name:** Elisanda Roca  
**Position:**  
**Organization:** Universitat de Barcelona  
**Component:**  
**Address:** Avd. Diagonal 647  
E-08028 Barcelona, SPAIN  
**Notes:** Co-author at 1992 SPIE IRFPA meeting of "Comparative Study of SWIR and MWIR Schottky-barrier Imagers"

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**Contact Name:** Tom Rockwell  
**Position:** CEO  
**Organization:** Rockwell Engineering Co., Inc.  
**Component:**  
**Address:** 2121 E. 45th St  
Indianapolis, IN, 46205  
**Notes:** Optical radiation research.

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**Contact Name:** Bill Rogatto  
**Position:** VP for FPA Development and Producibility  
**Organization:** SBRC  
**Component:**  
**Address:** 75 Coromar Drive  
Goleta, CA 93117  
**Notes:**

**Contact Name:** Michael Roitberg  
**Position:**  
**Organization:** Atomergic Chemetals Corporation  
**Component:**  
**Address:** 222 Sherwood Avenue  
Farmingdale, NY 11735  
**Notes:** Material processing of CdTe, GaAs, Germanium, Silicon, ZnS, and ZnSe.

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**Contact Name:** Brett Rosner  
**Position:** Senior Engineer  
**Organization:** Santa Barbara Focalplane  
**Component:**  
**Address:** 69 Santa Felicia Drive  
Goleta, CA 93117  
**Notes:** One of first firms marketing cameras based on focal plane arrays, InSb based.

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**Contact Name:** Richard Ross  
**Position:** CEO  
**Organization:** Diagnostic Retrieval Systems, Inc.  
**Component:** Photonics Corporation  
**Address:** 270 Motor Pkwy.  
Hauppauge, NY 11788  
**Notes:** Develop and manufacture optical laser ultraviolet detection components, missile optical component and specialized coating, mostly for military applications.

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**Contact Name:** D.V. Rossi  
**Position:**  
**Organization:** Columbia University  
**Component:**  
**Address:** New York, NY  
**Notes:** Co-authored for 1990 SPIE workshop on IR Detectors "GaAs CCD Readout for Engineered Bandgap Detectors"



**Contact Name:** Ralph Rotolante  
**Position:**  
**Organization:** Vicon Infrared  
**Component:**  
**Address:** Four Seneca Court  
Acton, MA 01720  
**Notes:** Former founder and president of the now defunct New England Research Center. Private consultant

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**Contact Name:** Cathy Rude  
**Position:** Marketing Communications  
**Organization:** Alliant Techsystems  
**Component:**  
**Address:** 5901 Lincoln Drive  
Edina, MN 55436  
**Notes:** Thermal Imaging, Night vision, detectors and sensors for military

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**Contact Name:** Brian Rushton  
**Position:** VP R&D  
**Organization:** Air Products and Chemicals, Inc.  
**Component:** Gas Group  
**Address:** 7201 Hamilton Blvd  
Allentown, PA 18195-1501  
**Notes:** Applications R&D for infrared spectroscopy.

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**Contact Name:** R.P. Ruth  
**Position:**  
**Organization:** SBRC  
**Component:**  
**Address:** 75 Coromar Drive  
Goleta, CA 93117  
**Notes:** Research scientist doing their MCT IRFPA projects

**Contact Name:** A. Ruzin  
**Position:**  
**Organization:** Kidron Microelectronics Research Center  
**Component:** Department of Electrical Engineering  
**Address:** Technion-Israel Institute of Technology  
Haifa 32000, ISRAEL  
**Notes:** "UV Photon Assisted Control of Interface Charge Between CdTe Substrates and Metal Organic Chemical Vapor Deposition CdTe Epilayers" for 1992 MCT Workshop.

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**Contact Name:** Morteza Safai  
**Position:**  
**Organization:** The Boeing Company  
**Component:** Boeing Defense and Space Group  
**Address:** Quality Assurance Research and Development  
P.O. Box 399, MS 85-08  
Seattle, WA 98124-2499  
**Notes:** infrared non-destructive evaluation

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**Contact Name:** MS Sandhu  
**Position:** Pres  
**Organization:** SRS Technology  
**Component:**  
**Address:** Suite 402 3501 Jamboree  
Newport Beach, CA 92660  
**Notes:** Development of smart sensors, conformal-array antennas, image processing, field measurements, and process control systems.

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**Contact Name:** Ginette Sarrazin  
**Position:** Service Publicite  
**Organization:** Societe de Frabrication d'Instruments de Mcsure  
**Component:**  
**Address:** 13 avenue Ramolfo Garnier  
F91344 Massy Dedex FRANCE  
**Notes:** Thermal imaging, night vision equipment for European military market.

**Contact Name:** T. Sasaki  
**Position:**  
**Organization:** NEC Corporation  
**Component:**  
**Address:** 4-1-1 Miyazaki  
Miyamae, Kawasaki, 216 JAPAN  
**Notes:** Co-authored for 1991 MCT Workshop "Study of CdTe Epitaxial Growth on (211)B GaAs by MBE"

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**Contact Name:** Thomas Scanlon  
**Position:**  
**Organization:** Inframetrics, Inc.  
**Component:**  
**Address:** 16 Esquire Road  
North Billerica, MA 01862  
**Notes:** Active in setting up infrared predictive maintenance regimes for Inframetric's customers.

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**Contact Name:** S.E. Schacham  
**Position:**  
**Organization:** Kidron Microelectronics Research Center  
**Component:** Department of Electrical Engineering  
**Address:** Technion-Israel Institute of Technology  
Haifa 32000, ISRAEL  
**Notes:** For 1991 MCT Workshop Co-authored "Covered Electrode HgCdTe Photoconductor Under High Illumination Levels"  
  
and for 1992 SPIE meeting on MCT "P-Channel MIS Double-Metal Process InSb Monolithic Unit Cell for Infrared Imaging"

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**Contact Name:** Dr Eugene Scheide  
**Position:** Pres  
**Organization:** Environmetrics, Inc.  
**Component:**  
**Address:** 2345 Millpark Dr.  
Maryland Heights, MO, 63043  
**Notes:** Development of "smart sensors," chemical sensors, development of gas sensing instruments

**Contact Name:** J.F. Schetzina  
**Position:**  
**Organization:** North Carolina State University  
**Component:** Department of Physics  
**Address:** Raleigh, NC 27695-8202  
**Notes:** On Program Committee of 1991 & 1992 MCT Workshop, and Authored for 92 MCT workshop "Growth of HgSe and HgCdSe Thin Films by Molecular Beam Epitaxy," and "Integrated Heterostructure Devices Based on II-VI Compound Semiconductors."  
For 1991 Workshop, co-authored "Properties of CdZnTe Crystals Grown by a High Pressure Bridgman Method" and "Quantum Hall Effect and Setback Modulation Doping HgTe-CdTe Heterostructures"

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**Contact Name:** J.T. Schick  
**Position:**  
**Organization:** Wayne State University  
**Component:** Department of Physics and Astronomy  
**Address:** Detroit, MI  
**Notes:** Co-authored 1990 article, 6 pages, "Structural Energies of Defects in CdTe and HgCdTe"  
  
And co-authored April 1990 "Point Defects in Lattice Distortion in CdTe and HgCdTe"

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**Contact Name:** J. Schieferdecker  
**Position:**  
**Organization:** Dresden University of Technology  
**Component:** Institut für Festkörperelektronik  
**Address:** Dresden, FEDERAL REPUBLIC OF GERMANY  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Pyroelectric Linear Array IR Detectors with CCD Multiplexer"

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**Contact Name:** Frederick Schmid  
**Position:** CEO  
**Organization:** Crystal Systems Inc.  
**Component:**  
**Address:** Shetland Industrial Park  
27 Congress St.  
Salem, MA 01970  
**Notes:** Growth of semiconductors using such materials as GaAs and CdTe, and use of silicon in infrared applications in both commercial and military markets.

**Contact Name:** Frederick Schmid  
**Position:** CEO  
**Organization:** Crystal Systems Inc.  
**Component:**  
**Address:** Shetland Industrial Park  
27 Congress St.  
Salem, MA 01970  
**Notes:** Growth of semiconductors using such materials as GaAs and CdTe, and use of silicon in infrared applications. Work for both military and commercial markets.

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**Contact Name:** Michael Schneider  
**Position:**  
**Organization:** Research Devices, Inc.  
**Component:**  
**Address:** 121 Ethel Road West  
Piscataway, NJ 08854  
**Notes:** Authored for 1992 SPIE Workshop on MCT "Hybridizing Focal Plane Arrays."

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**Contact Name:** Marija S. Scholl  
**Position:**  
**Organization:** California Institute of Technology  
**Component:** Jet Propulsion Laboratory  
**Address:** 4800 Oak Grove Drive  
Pasadena, CA 91009-8099  
**Notes:** Editor of upcoming January 1994 edition of the SPIE's Optical Engineering journal, focusing on infrared technology.

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**Contact Name:** James R. Schott  
**Position:**  
**Organization:** Worcester Institute of Technology  
**Component:** Center for Imaging Science  
**Address:** One Lomb Memorial Drive  
Rochester, NY 14623  
**Notes:** active in infrared remote sensing

**Contact Name:** L.J. Schowalter  
**Position:**  
**Organization:** Rensselaer Polytechnic Institute  
**Component:** Physics Department and Center for Integrated Electronics  
**Address:** 110 Eight Street  
Troy, NY 12180  
**Notes:** Co-authored for 1992 meeting of SPIE on IRFPAs "Fundamental Studies of Schottky Barrier IR Detectors by Ballistic Electron Emission Microscopy"

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**Contact Name:** Frank Schrontz  
**Position:** CEO  
**Organization:** The Boeing Company  
**Component:**  
**Address:** 7755 E Marginal Way S, PO Box 3707 Seattle, WA 98124  
**Notes:** Research in the field of aerospace including sensor systems.

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**Contact Name:** Mangred Schuck  
**Position:** Senior Manager  
**Organization:** Rodenstock Industrial Optics  
**Component:**  
**Address:** P.O. Box 14 04 40  
Jsartalstrasse 43  
D-8000 Munich 5, GERMANY  
**Notes:** Infrared systems & equipment, e/o systems, thermal imaging for military applications.

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**Contact Name:** Carl Schueller  
**Position:** Manager, Advanced Development Programs  
**Organization:** SBRC  
**Component:**  
**Address:** 75 Coromar Drive  
Goleta, CA 93117  
**Notes:**

**Contact Name:** M.J. Schulz  
**Position:**  
**Organization:** University of Erlangen  
**Component:**  
**Address:** Erlangen, GERMANY  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Electronic and Optical Properties of Silicide/ Silicon IR Detectprs"

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**Contact Name:** Norman Schumaker  
**Position:** CEO  
**Organization:** Emcore Corp.  
**Component:**  
**Address:** 35 Elizabeth Avenue  
Somerset, NJ 08873  
**Notes:** Material production of GaAs, CdTe, silicon, ZnS, and ZnSe for infrared applications.

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**Contact Name:** WC Schwartz  
**Position:** President  
**Organization:** Schwartz Electro-Optics  
**Component:**  
**Address:** 3404 N Orange Blossom Trail  
Orlando, FL 32804  
**Notes:** Manufactures near and mid-IR solid-state lasers for research, medical, industrial, and OEM applications. Knowledgeable in photofluorescence in IR, using IR detectors.

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**Contact Name:** Edward Scicchitano  
**Position:** CEO  
**Organization:** DTX Corporation  
**Component:** Dynatherm Corporation  
**Address:** One Beaver Ct.  
Cockeysville, MD 21030  
**Notes:** Thermal systems research oriented toward industrial process temperature control.

**Contact Name:** M Seelmann-Eggebert  
**Position:**  
**Organization:** Fraunhofer-Institut fur Angewandte Festkorperphysik  
**Component:**  
**Address:** D-7800 Freiburg, GERMANY  
**Notes:** Authored "XPD Investigation of Substrate Crystallinity at HgCdTe (111B) and CdTe(111)B Surfaces Upon Ag and Al Overlayer Formation."  
For 1991 Workshop "Photoemission Spectroscopic Techniques to Assess Physical and Chemical Properties of Mercury Cadmium Telluride"

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**Contact Name:** Milton Seiler  
**Position:**  
**Organization:** Battelle Memorial Institute  
**Component:**  
**Address:** 505 King Avenue  
Columbus, OH 43201-2693  
**Notes:** Designs infrared non-destructive evaluation applications.

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**Contact Name:** D.G. Sciler  
**Position:**  
**Organization:** National Institute of Standards and Technology  
**Component:** Semiconductor Electronics Division  
**Address:** Gaithersburg, MD 20899  
**Notes:** On Program Committee, and Co-Authored "Heavily Accumulated Surfaces of MCT Detectors: Theory and Experiment" for 1992 MCT Workshop.  
Co-Authored for 1991 Workshop "Investigation of Mercury Interstitials in MCT alloys Using Resonant Impact-Ionization Spectroscopy"

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**Contact Name:** Sharon A. Semanovich  
**Position:** Ms.  
**Organization:** Allen Infrared Associates  
**Component:**  
**Address:** RR #1, Box 239K  
Coward, SC 29530  
**Notes:** Assistant to Allen, active in design of infrared predictive maintenance regimes



**Contact Name:** Martin Sensiper  
**Position:**  
**Organization:** University of Central Florida  
**Component:** Electrical Engineering Department and Center for Research in Electro-Optics and Lasers  
**Address:** 12424 Research Parkway, Suite 400  
Orlando, FL 32828  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Use of Narrowband Laser Speckle for MTF Characterization of CCDs"

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**Contact Name:** Becky Setzler  
**Position:** Media Relations Program Manager  
**Organization:** Texas Instruments  
**Component:**  
**Address:** P.O. Box 660246 MS 3134  
Dallas, TX 75266-0246  
**Notes:** INfrared systems & equipment, thermal imaging, detectors & sensors

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**Contact Name:** Keith Seybald  
**Position:** Melec  
**Organization:** Angstrom Technologies, Inc.  
**Component:**  
**Address:** PO Box 607  
Florence, KY 41042  
**Notes:** Basic and applied electro-optical vision for robotics and automated guided vehicles; applied and product-oriented research in packaging and material handling vision systems.

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**Contact Name:** Y. Shacham-Diamand  
**Position:**  
**Organization:** Cornell University  
**Component:** School of Electrical Engineering and the National Nanofabrication Facility  
**Address:** Ithaca, NY 14853  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "P-Channel MIS Double-Metal Process InSb Monolithic Unit Cell for Infrared Imaging"

**Contact Name:** R.R. Shannon  
**Position:**  
**Organization:** Arizona University  
**Component:** Optical Sciences Center  
**Address:** Tucson, AZ  
**Notes:** Authored March 1990 "Research in the Optical Sciences" which reviews the progress of their optical sciences center, including growth of semiconductors through LPE and VPE. Some MCT and CZT research

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**Contact Name:** Richard Shaps  
**Position:** Dvmgr  
**Organization:** Bio-Rad Laboratories  
**Component:** Digilab Division  
**Address:** 237 Putnam Avenue  
Cambridge, MA 02139  
**Notes:** Manufactures fourier transform IR spectrometers.

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**Contact Name:** Dick Sharmam  
**Position:** General Manager  
**Organization:** Exotic Materials, Inc,  
**Component:**  
**Address:** 2930 Bristol St.  
Costa Mesa, CA 92626  
**Notes:** Applied, product-oriented research as related to electro-optical materials, vacuum deposited coatings and devices for government, industrial and military systems applications.

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**Contact Name:** M.C. Shaw  
**Position:**  
**Organization:** Arizona State University  
**Component:**  
**Address:** Tempe, AZ 85287-5506  
**Notes:** Co-authored 1983 "Application of Infrared Radiation Measurements in Grinding Studies." MCT-based materials research

**Contact Name:** Dr Manny Shaw  
**Position:** Pres  
**Organization:** Interscan Corporation  
**Component:**  
**Address:** 21700 Nordhoff St. PO Box 2496  
Chatworth, CA 91313-2496  
**Notes:** Gas analyzer and sensor developments.

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**Contact Name:** Diane R. Sheerar  
**Position:** Manager Marketing Services  
**Organization:** Brunswick Technical Group  
**Component:**  
**Address:** 1 Brunswick Plaza  
Skokie, IL 60077  
**Notes:** Infrared Systems and Equipment predominantly for military markets

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**Contact Name:** A. Sher  
**Position:**  
**Organization:** SRI International  
**Component:**  
**Address:** Menlo Park, CA 94025  
**Notes:** On Program Committee, and Co-Author of "Native Defect Equilibria in HgZnTe and HgCdTe Alloys" for 1992 MCT Workshop.  
On 1991 MCT Workshop Program Committee; co-authored "Defect Equilibrium in HgTe"

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**Contact Name:** K. Shigenaka  
**Position:**  
**Organization:** Toshiba Corporation  
**Component:** Research and Development Center  
**Address:** Komukai Works  
Kawasaki, Japan  
**Notes:** Co-authored for 1992 MCT Workshop "Effects of Growth Rate and Mercury Partial Pressure on Twin Formation in HgCdTe (111) Layers Grown by MOCVD"

**Contact Name:** Lee Shiozawa  
**Position:**  
**Organization:** Cleveland Crystals, Inc.  
**Component:**  
**Address:** 19306 Redwood Avenue, P.O Box 17157 Cleveland, OH 44117  
**Notes:** Manufacturer and research into CdTe, ZnS, and ZnSe infrared materials, specialty in II-VI, for both military and commercial markets.

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**Contact Name:** Michael Shur  
**Position:**  
**Organization:** Virginia University  
**Component:** Department of Electrical Engineering  
**Address:** Charlottesville, VA  
**Notes:** Co-authored May 1992 report "Monte Carlo Simulation of Electron Transport in HgCdTe"

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**Contact Name:** Dr Joseph Siewick  
**Position:** CEO  
**Organization:** Science & Engineering Consultants, Inc.  
**Component:**  
**Address:** Suite 300, 1820 discovery St.  
Reston, VA 22090-5610  
**Notes:** Research in imaging and remote sensing.

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**Contact Name:** Orman Simpson  
**Position:** Pres  
**Organization:** MDA Scientific, Inc.  
**Component:**  
**Address:** Suite 185, 3000 Northwoods Pkwy  
Norcross, GA 30071  
**Notes:** Optical remote sensing techniques.

**Contact Name:** J. Singh  
**Position:**  
**Organization:** University of Michigan  
**Component:** Department of Electrical Engineering and Computer Science  
**Address:** Ann Arbor, MI 48109  
**Notes:** Co-Author of "Recent Advances on HgCdTe Mid Infrared Diode Lasers" for 1992 MCT Workshop.

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**Contact Name:** Nicholas Sink  
**Position:** Gen. Mgr.  
**Organization:** Semiconductor Processing Co., Inc.  
**Component:**  
**Address:** 409 East First Street  
Boston, MA 02127  
**Notes:** Manufacturer of GaAs, germanium, and silicon for infrared applications.

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**Contact Name:** S. Sivananthan  
**Position:**  
**Organization:** University of Illinois at Chicago  
**Component:** Microphysics Laboratory, Physics Department  
**Address:** P.O. Box 4348  
Chicago, IL 60680  
**Notes:** Authored "Structure of CdTe(111)B grown by MBE on Misoriented Si(001)" and "Influence of CdZnTe(211)B Substrate on Electrical Properties of HgCdTe Grown by MBE" for 1992 MCT Workshop.  
  
For 1991 Workshop, "Current Status of Direct Growth of CdTe and HgCdTe on Silicon by MBE"

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**Contact Name:** R. Sizmann  
**Position:**  
**Organization:** Technische Universität  
**Component:** Physik-Department E-16  
**Address:** München, D-8046  
GERMANY  
**Notes:** Co-authored for 1991 MCT Workshop "Influence of Resonant Defect States on Subband Structures in HgCdTe"

**Contact Name:** John Skurla  
**Position:** Sales Manager  
**Organization:** EG&G Reticon Corp.  
**Component:**  
**Address:** 345 Potrero Avenue  
Sunnyvale, CA 94086-4197  
**Notes:** Manufactures photodiode semiconductor detectors, detector arrays, CCPD image sensors, solid-state and line scan and area scan, and circular cameras

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**Contact Name:** Joseph Slawek  
**Position:** Gmgr  
**Organization:** EG&G, Inc.  
**Component:** EG&G Judson  
**Address:** 221 Commerce Dr.  
Montgomeryville, PA 18936  
**Notes:** Application of infrared materials including germanium and mercury cadmium telluride.

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**Contact Name:** Jon Slaybaugh  
**Position:** Gmgr  
**Organization:** Acme-Cleveland Corporation  
**Component:** Namco Controls Division  
**Address:** 7567 Tyler Blvd.  
Mentor, OH 44060  
**Notes:** Product oriented R&D of electronic measurement and control devices including photoelectric sensors, laser guidance, identification and tracking devices.

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**Contact Name:** Lee Slizewski  
**Position:**  
**Organization:** American Risk Management Corp.  
**Component:**  
**Address:** P.O. Box 1042  
West Brookfield, MA 01585-1042  
**Notes:** Design infrared predictive maintenance regimes for factories, esp. nuclear power plants

**Contact Name:** Mitchell R. Smigield  
**Position:** Dr.  
**Organization:** Scott-White Clinic  
**Component:**  
**Address:** Temple, TX 76501  
**Notes:** Active in infrared biomedical thermography research.

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**Contact Name:** Philip Smith  
**Position:** President  
**Organization:** Agema Infrared Systems  
**Component:**  
**Address:** 550 County Avenue.  
Secaucus, N.J. 07094  
**Notes:** Manufactures infrared thermal imaging systems for condition monitoring, process monitoring and control, military/ defense research, surveillance and the nondestructive measurement and analysis of materials and components.

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**Contact Name:** Phillip A. Smith  
**Position:** National Sales Manager  
**Organization:** Amber Engineering  
**Component:**  
**Address:** 5756 Stonewood Drive  
Goleta, CA 93117  
**Notes:** Participant in DARPA's IRFPA team and producer of InSb used in medium-wave infrared systems. Designs systems for both commercial and military markets. Amber's speciality is emissivity correction.

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**Contact Name:** L.M. Smith  
**Position:**  
**Organization:** GEC Hirst Research Centre  
**Component:**  
**Address:** Wembley, UNITED KINGDOM  
**Notes:** Co-authored May 1990 report "Integrated Technology in MCT/GaAs and MCT/Si for Medium and Long Wavelength Infrared"

**Contact Name:** Carol Smith  
**Position:** Ms.  
**Organization:** Wahl Instruments, Inc.  
**Component:**  
**Address:** 5750 Hunnum Ave.,  
Culver City, CA 90231  
**Notes:** Production of non-contact IR thermometers for industrial processes.

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**Contact Name:** John R. Snell  
**Position:**  
**Organization:** John Snell & Associates  
**Component:**  
**Address:** 17 First Avenue  
Montpelier, VT 05602  
**Notes:** Active in infrared predictive maintenance as inspector of plants and factories.  
Widely published author on predictive maintenance.

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**Contact Name:** Ed Snow  
**Position:** GrEx  
**Organization:** EG&G, Inc.  
**Component:** EG&G Optoelectronics  
**Address:** 22001 Dumberry  
Vaudervil, PQ J7V 8P7  
**Notes:** R&D of optical emitters and detectors.

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**Contact Name:** Thomas Soderman  
**Position:** Pres  
**Organization:** Bath Electrical Systems  
**Component:**  
**Address:** 5009 N Hwy 288 B, PO Box 198  
Clute, TX 77531  
**Notes:** Design and development of systems for infrared scanning for energy losses problems.



**Contact Name:** R Sommer  
**Position:** Pres  
**Organization:** IR Scientific Inc  
**Component:**  
**Address:** PO Box 110  
Carlisle, MA 01741  
**Notes:** Product-oriented near infrared research and development manufacturing and infrared consulting services.

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**Contact Name:** J.L. Song  
**Position:**  
**Organization:** Columbia University  
**Component:**  
**Address:** New York, NY  
**Notes:** Co-authored for 1990 SPIE workshop on IR Detectors "GaAs CCD Readout for Engineered Bandgap Detectors"

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**Contact Name:** X.N. Song  
**Position:**  
**Organization:** University of Nort Texas  
**Component:** Department of Physics  
**Address:** Denton, TX 76203  
**Notes:** Co-Authored "Heavily Accumulated Surfaces of MCT Detectors: Theory and Experiment" for 1992 MCT Workshop.  
For 1991 Workshop, "Investigation of Mercury Interstititals in MCT alloys Using Resonant Impact-Ionization Spectroscopy"

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**Contact Name:** James Sorenson  
**Position:** General Manager  
**Organization:** Batelle Memorial Institute  
**Component:** Electronic Systems  
**Address:** 505 King Ave.  
Columbus, OH 43201  
**Notes:** Advanced development and integration of complex electronic and optical systems; development of large laser materials for interaction studies; automated inspection systems and optical systems for tracking reentry vehicles.

**Contact Name:** Robert A. Spangler  
**Position:** Dr.  
**Organization:** State University of NY at Buffalo  
**Component:** Dept of Biophysical Sciences  
**Address:** 120 Cary Hall  
Buffalo, NY 14214  
**Notes:** Active in infrared biomedical thermography, helped develop multi-wavelength camera which measures temperature independent of emissivity.

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**Contact Name:** Robert Spangler  
**Position:** Professor  
**Organization:** SUNY Buffalo  
**Component:** Department of Biological Sciences  
**Address:** 120 Cary Hall  
Buffalo, NY 14214  
**Notes:** An MD, with research interests in the application of classical and nonequilibrium thermodynamics in biological systems, membrane processes, stability properties, etc. as well as the development of novel medical diagnostic techniques. Advised Hejazi on OE article, Nov. 92, on IR detection of skin temperatures. Extremely knowledgeable on IR detectors biomedical. Interviewed 11-20-92.

---

**Contact Name:** John Spelman  
**Position:** Pres  
**Organization:** Environmental Technology Group, Inc.  
**Component:**  
**Address:** 1400 Taylor Ave., PO Box 9840  
Baltimore, MD 21284-9840  
**Notes:** Applied research in microsensor systems for chemicals, design and development of environmental, meteorological, biological and chemical sensors, detectors for explosives, hazardous drugs and chemical warfare agents.

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**Contact Name:** Jane Spicer  
**Position:** Ms.  
**Organization:** Johns Hopkins University  
**Component:** Center for NDE and Applied Physics Laboratory  
**Address:** Laurel, MD 20723  
**Notes:** Infrared non-destructive evaluation specialist at leading center.

**Contact Name:** R. Sporken  
**Position:**  
**Organization:** University of Illinois at Chicago  
**Component:** Microphysics Laboratory, Physics Department  
**Address:** P.O. Box 4348  
Chicago, IL 60680  
**Notes:** For 1991 Workshop, "Current Status of Direct Growth of CdTe and HgCdTe on Silicon by MBE"

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**Contact Name:** Robert W. Spring  
**Position:**  
**Organization:** John Snell & Associates  
**Component:**  
**Address:** 17 First Avenue  
Montpelier, VT 05602  
**Notes:** Active in infrared predictive maintenance as large New England consulting firm.

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**Contact Name:** K.K. Sreenivasan  
**Position:**  
**Organization:** Southern Methodist University  
**Component:**  
**Address:**  
**Notes:** Co-authored for 1992 SPIE meeting on Machine Vision "Automated Vision System for INSpection of Wedge Bonds"

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**Contact Name:** M.D. Srinath  
**Position:**  
**Organization:** Southern Methodist University  
**Component:**  
**Address:**  
**Notes:** Co-authored for 1992 SPIE meeting on Machine Vision "Automated Vision System for INSpection of Wedge Bonds"

**Contact Name:** Charles G Stanich  
**Position:** Vice President  
**Organization:** Daedalus Enterprises, Inc.  
**Component:**  
**Address:** 300 Parkland Plaza, PO Box 1869  
Ann Arbor, MI 48106  
**Notes:** Infrared and multispectral analysis systems for remote sensing.

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**Contact Name:** Michael Stanton-Hicks  
**Position:** Dr.  
**Organization:** Cleveland Clinic Foundation  
**Component:** Pain Management Center, M-60  
**Address:** 9500 Euclid Avenue  
Cleveland, OH 44195-5001  
**Notes:** User and innovator of infrared biomedical thermography

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**Contact Name:** Charles Staples  
**Position:** Pres  
**Organization:** Thorton Associates Inc  
**Component:**  
**Address:** 1432 Main St.  
Waltham, MA 02154  
**Notes:** Production of electronic control devices.

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**Contact Name:** Herman Statz  
**Position:** General Manager  
**Organization:** Raytheon Comp.  
**Component:** Research Division  
**Address:** 131 Spring St.  
Lexington, MA 02173  
**Notes:** Infrared window and detection materials and components, radar window materials, laser and electro-optics. Growth of CdTe on GaAs/Si and Si substrates for HgCdTe.

**Contact Name:** Bob Stauder  
**Position:** VP  
**Organization:** LaBarge Inc.  
**Component:** LaBarge Electronics  
**Address:** 11616 E 51st St.  
Tulsa, OK 74146  
**Notes:** Intrusion detection systems and components, telemetry systems and components and other electromechanical systems and components for airborne and space applications; atmospheric, weather and data measuring systems and components.

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**Contact Name:** Donald Sting  
**Position:** CEO  
**Organization:** Nicolet Instrument Corporation  
**Component:** Spectra Tech Inc.  
**Address:** 652 Glenbrook Rd, PO Box 2190-G  
Stamford, CT 06906  
**Notes:** Infrared spectroscopy instruments and applications.

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**Contact Name:** Charles Stokes  
**Position:** Dir  
**Organization:** Arvin Industries, Inc  
**Component:** Franklin Research Center  
**Address:** 2600 Monroe Blvd.  
Norristown, PA 19403  
**Notes:** Applied research, design, and development in electronic and electrical engineering, including electro-optics.

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**Contact Name:** JM Stone  
**Position:** Pres  
**Organization:** Dukane Corporation  
**Component:** Microbiotics Division  
**Address:** 2900 Dukane Dr.  
Saint Charles, IL 60174  
**Notes:** Precision automated alignment and laser welding systems used to manufacture optoelectronic devices.

**Contact Name:** Harry Stonecipher  
**Position:** Pres  
**Organization:** Sunstrand Corp.  
**Component:** Analytical Productions Division  
**Address:** 820 Linden Ave.  
Rochester, NY 14625  
**Notes:** Image analysis equipment systems and color spectrometry.

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**Contact Name:** Arthur Stout  
**Position:** National Sales Manager  
**Organization:** Agema IR Systems  
**Component:**  
**Address:** 550 County Avenue  
Secaucus, NJ 07094  
**Notes:**

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**Contact Name:** Arthur Stout  
**Position:** Marketing  
**Organization:** Inframetrics, Inc.  
**Component:**  
**Address:** 16 Esquire Road  
Billerica, MA 01862  
**Notes:** Active in infrared remote sensing, predictive maintenance, nondestructive evaluation markets for Inframetrics.

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**Contact Name:** Terry Stratten  
**Position:** Vice President  
**Organization:** General Dynamics Corporation  
**Component:** Electronics Division  
**Address:** 5011 Kearny Villa Rd.  
San Diego, CA 92123-1447  
**Notes:** Product oriented research in automatic test equipment and electronics, communications, electronic warfare, signal processing, and displays and imagery, lasers. For military markets.

**Contact Name:** Dr Terry Straetten  
**Position:** VP  
**Organization:** General Dynamics Corporation  
**Component:** Electronics Division  
**Address:** 5011 Kearny Villa Rd.  
San Diego, CA 92123-1447  
**Notes:** Product oriented research in automatic test equipment and electronics, communications, electronic warfare, signal processing, and displays and imagery, lasers for military markets.

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**Contact Name:** Robert Stratton  
**Position:** VP  
**Organization:** Texas Instruments Inc  
**Component:** Central Research Laboratories  
**Address:** PO Box 655936, MS 136  
Dallas, TX 75265  
**Notes:** Production of HgCdTe-based infrared imagers.

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**Contact Name:** Joe Straub  
**Position:** Manager, Signal Processing Systems  
**Organization:** Pacer Systems, Inc.  
**Component:**  
**Address:** 900 Technology Park Drive  
Billerica, MA 01803  
**Notes:** Infrared systems & equipment for military applications.

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**Contact Name:** Reggie Stroupe  
**Position:** Pres  
**Organization:** Andersen Instruments, Inc.  
**Component:** Nutech Corporation  
**Address:** 2806 Check Rd  
Durham, NC 27704  
**Notes:** Applied and product-oriented research in the areas of air pollution sampling, filter systems, electronic sensors and controls, temperature control, chromatography, and laboratory research instruments, medical electronics and mass spectrometry.

**Contact Name:** Gary Stutte  
**Position:**  
**Organization:** University of Maryland  
**Component:** Maryland Agricultural Experiment Station  
**Address:** College Park, MD 20742  
**Notes:** active in infrared remote sensing

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**Contact Name:** Miles Suer  
**Position:** Director of Marketing  
**Organization:** Irvine Sensors Corp.  
**Component:**  
**Address:** 3001 Redhill Ave Bldg 3  
Costa Mesa, CA 92626  
**Notes:** Applied research in military detection system (infrared sensing).

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**Contact Name:** C.J. Summers  
**Position:**  
**Organization:** Georgia Institute of Technology  
**Component:**  
**Address:**  
**Notes:** On Program Committee of 1991 & 1992 MCT Workshop  
For 1991 Workshop, "Selected-area Epitaxy on CdTe," and "Gas Source Iodine  
Doping and Characterization of MBE Grown CdTe"

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**Contact Name:** Tai-Ping Sun  
**Position:**  
**Organization:** Chung-Shan Institute of Science and Technology  
**Component:**  
**Address:** P.O. Box 90008-8-7, Lung-tan, Tao-Yuan  
REPUBLIC OF CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "A Novel CID Emulator for  
InSb Array"



**Contact Name:** John Sun  
**Position:** VP  
**Organization:** ITI Electro-Optics Corp.  
**Component:**  
**Address:** 11500 W Olympic Blvd  
Los Angeles, CA 90064  
**Notes:** Manufacture of CdTe, GaAs, germanium, ZnS, and ZnSe for infrared technologies.

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**Contact Name:** James Swanson  
**Position:** President  
**Organization:** Ramtek Corporation  
**Component:**  
**Address:** 1525 Atteberry Lane  
San Jose, CA  
**Notes:** Remote sensing systems, multispectral system design, for both military and commercial markets.

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**Contact Name:** M.L. Swanson  
**Position:**  
**Organization:** University of North Carolina at Chapel Hill  
**Component:** Department of Physics and Astronomy  
**Address:** Chapel Hill, NC 27599-3255  
**Notes:** Co-Authored "Observation of Indium-Vacancy and Indium Hydrogen Interactions in (HgCd)Te Using PAC

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**Contact Name:** Ron Swarbrick  
**Position:** Marketing Director  
**Organization:** EG&G, Inc.  
**Component:** EG&G Optoelectronics  
**Address:** 22001 Dumberry  
Vaudervil, PQ J7V 8P7  
CANADA  
**Notes:** R&D of optical emitters and detectors.

**Contact Name:** Tony Sweet  
**Position:** Marketing Director  
**Organization:** EG&G Reticon Corp.  
**Component:**  
**Address:** 345 Potrero Avenue  
Sunnyvale, CA 94086-4197  
**Notes:** Manufactures photodiode semiconductor detectors, detector arrays, CCPD image sensors, solid-state and line scan and area scan and circular cameras

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**Contact Name:** H. Takigawa  
**Position:**  
**Organization:** Fujitsu Laboratories, Ltd.  
**Component:** Atsugi Infrared Devices Laboratory  
**Address:** 10-1 Morinosato-Wakamiya  
Atsugi 243-01 JAPAN  
**Notes:** Authored for 1992 MCT Workshop "Mercury Cadmium Telluride in Japan"

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**Contact Name:** E.M. Talund  
**Position:** Defece Sales  
**Organization:** Scandinavian Avionics  
**Component:**  
**Address:** Billund Airport  
P.O. Box 59  
7190 Billund, DENMARK  
**Notes:** Infrared systems and equipment, thermal imaging, night vision for military applications.

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**Contact Name:** A. Tanabe  
**Position:**  
**Organization:** NEC Corporation  
**Component:** Microelectronics Research Laboratories  
**Address:** 1120, Shimokuzawa, Kanagawa 229, JAPAN  
**Notes:** Co-authored for 1992 SPIE workshop on IRFPAs "Optimum Barrier Height in Schottky-Barrier Infrared CCD Image Sensor"

**Contact Name:** JD Tarbet  
**Position:** VPeng  
**Organization:** Crane Co  
**Component:** Hydro-Aire Division  
**Address:** 3000 Winona Ave.  
Burbank, CA 91504  
**Notes:** Infrared tracking for wind shear detection and high response control synthesis for extra fast control systems.

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**Contact Name:** Bor-Yeu Tasur  
**Position:**  
**Organization:** MIT  
**Component:** Lexington Lincoln Lab  
**Address:** 244 Wood Street  
Lexington, MA 02173-9108  
**Notes:** Co-authored April 1990 study entitled "PtSi Schottky-Barrier Focal Plane Arrays for Multispectral Imaging in Ultraviolet, Visible, and Infrared Spectral Bands"  
  
Co-authored August 1989 study entitled "128X128 Element IrSi Schottky-Barrier Focal Plane Arrays for LWIR Imaging"

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**Contact Name:** David Taylor  
**Position:** Sales Manager  
**Organization:** EEV Ltd.  
**Component:**  
**Address:** Waterhouse Lane  
Chelmsford, Essex ENGLAND CM1 2QU  
**Notes:** Active and passive eo systems, infrared systems and equipment, night vision for military.

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**Contact Name:** Gary Teagarden  
**Position:** Dir. Marketing Communications  
**Organization:** Paramax Systems Corp.  
**Component:**  
**Address:** 8201 Greensboro Drive, Suite 1000  
McLean, VA 22102  
**Notes:** Passive and active c/o systems, c/o systems, infrared systems and equipment for military applications.

**Contact Name:** Peter Teets  
**Position:** Pres  
**Organization:** Martin Marietta Corporation  
**Component:** Martin Marietta Astronautics Group  
**Address:** Mail No S4400, PO Box 179  
Denver, CO 80201  
**Notes:** Research into optical detection, optical control, electronic systems design, and thermal control systems.

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**Contact Name:** Jay Teich  
**Position:** VP for Commercial Products  
**Organization:** Inframetrics  
**Component:**  
**Address:** 16 Esquire Road  
North Billerica, MA 01862-2598  
**Notes:**

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**Contact Name:** John Tengelsen  
**Position:** Pres.  
**Organization:** Lattice Materials Corp.  
**Component:**  
**Address:** 516 E. Tamrack  
Bozeman, MT 59715  
**Notes:** Manufacturer of silicon for infrared applications.

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**Contact Name:** William Tennant  
**Position:** Dr.  
**Organization:** Rockwell International Science Center  
**Component:**  
**Address:** 1049 Camino Dos Rios  
Thousand Oaks, CA 91360  
**Notes:** Chief scientist on IR producibility efforts, substrate issues.

**Contact Name:** Dennis Thomas  
**Position:**  
**Organization:** Eagle-Picher Industries, Inc.  
**Component:** Electro-Optic Materials Department  
**Address:** P.O. Box 737  
Quapaw, OK 74363  
**Notes:** Production of germanium and silicon systems for infrared applications.

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**Contact Name:** Robert L. Thomas  
**Position:**  
**Organization:** Wayne State University  
**Component:** Institute for Manufacturing Research  
**Address:** Detroit, MI 48202  
**Notes:** infrared non-destructive evaluation

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**Contact Name:** Earl Thompson  
**Position:** President  
**Organization:** Delta International, Inc.  
**Component:**  
**Address:** 2111 Wilson Boulevard, Suite 700  
Arlington, VA 22201  
**Notes:** Thermal imaging, detectors and sensors for military applications.

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**Contact Name:** W.R. Thurber  
**Position:**  
**Organization:** National Institute of Standards and Technology  
**Component:** Semiconductor Electronics Division  
**Address:** Gaithersburg, MD 20899  
**Notes:** Co-Authored "Heavily Accumulated Surfaces of MCT Detectors: Theory and Experiment" for 1992 MCT Workshop.

**Contact Name:** Roger Titrone  
**Position:** Pres  
**Organization:** Titronics Inc  
**Component:**  
**Address:** RR 1, Box 53B  
Oxford, IA 52322  
**Notes:** Infrared terrain scanning.

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**Contact Name:** Glenn Todd  
**Position:** EW Requirements Manager  
**Organization:** Texas Instruments  
**Component:** Defense Systems and Electronics Group  
**Address:** 2501 W. University  
McKinney, TX 95070  
**Notes:** infrared systems and equipment

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**Contact Name:** Glenn Tom  
**Position:** VPres Research  
**Organization:** Advanced Technology Materials  
**Component:**  
**Address:** 520-B Danbury Road  
New Milford, CT 06776  
**Notes:** Recently awarded an SDIO contract to develop a new electronic thin-film material to improve IR detector technology. The company will focus on using barium strontium titanate to develop new sensors capable of operating at room temperature.

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**Contact Name:** Fei-Ming Tong  
**Position:**  
**Organization:** Shanghai Institute of Technical Physics  
**Component:** Chinese Academy of Sciences  
**Address:** Shanghai, 20092 CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "HgCdTe Photovoltaic Detectors and Some Related Aspects"

**Contact Name:** Christopher Toth  
**Position:** President  
**Organization:** Superior Evaporants  
**Component:**  
**Address:** 6965 Highway 9  
Felton, CA 95018  
**Notes:** Manufacturer of germanium, silicon, ZnS, and ZnSe for infrared systems.

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**Contact Name:** John R. Tower  
**Position:** Manager, Visible and IR Imaging Business  
**Organization:** David Sarnoff Research Center  
**Component:**  
**Address:** CN5300 Washington Road  
Princeton, NJ 08543-5300  
**Notes:** Oversees their PtSi Schottky-barrier IR focal plane array technology work

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**Contact Name:** Steven Towne  
**Position:** Public Relations  
**Organization:** Loral Infrared and Imaging Systems  
**Component:**  
**Address:** 2 Forbes Road  
Lexington, MA 02173  
**Notes:** Detectors and sensors, night vision, thermal imaging, infrared systems & equipment, predominantly for military applications.

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**Contact Name:** Russell L. Travis  
**Position:** Dr.  
**Organization:**  
**Component:**  
**Address:** 152 W. Zandale Drive  
Lexington, KY 40503  
**Notes:** Doctor in private practice, active in infrared biomedical thermography

**Contact Name:** Roger B. Traycoff  
**Position:** Dr.  
**Organization:** Southern Illinois Univ School of Medecine  
**Component:**  
**Address:** P.O. Box 9230  
Springfield, IL 62794-9230  
**Notes:** Active in use of infrared biomedical thermography, on board of directors of American Academy of Thermology.

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**Contact Name:** R. Triboulet  
**Position:**  
**Organization:** CNRS  
**Component:** Laboratoire de Physique des Solides de Bellevue  
**Address:** 1, Place Aristide Briand  
F. 92125 Meudon Cedex FRANCE  
**Notes:** Co-authored for 1992 MCT Workshop "Substrate Issues for Mercury Cadmium Telluride"

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**Contact Name:** Charles T. Troy  
**Position:**  
**Organization:** Photonics Spectra Magazine  
**Component:**  
**Address:** Berkshire Common  
P.O. Box 4949  
Pittsfield, MA 01202-4949  
**Notes:** Follows infrared remote sensing as journalist

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**Contact Name:** Martha Tulloch  
**Position:** Ms.  
**Organization:** Photonics Spectra Magazine  
**Component:**  
**Address:** Berkshire Common  
P.O. Box 4949  
Pittsfield, MA 01202-4949  
**Notes:** Follows applications for infrared technologies as magazine's associate editor.



**Contact Name:** Mike Turley  
**Position:** Marketing Director  
**Organization:** Computing Devices Co.  
**Component:**  
**Address:** Castleham Road  
St. Leonards on Sea  
East Sussex, UK TN389NJ  
**Notes:** Infrared systems and Equipment primarily for military markets.

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**Contact Name:** S. Kay Turner  
**Position:** VP Marketing  
**Organization:** Loral Corporation  
**Component:** Loral Infrared & Imaging Systems, Inc.  
**Address:** 2 Forbes Rd.  
Lexington, MA 02173  
**Notes:**

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**Contact Name:** B.R. Turner  
**Position:**  
**Organization:** Rensselaer Polytechnic Institute  
**Component:** Physics Department and Center for Integrated Electronics  
**Address:** 110 Eight Street  
Troy, NY 12180  
**Notes:** Co-authored for 1992 meeting of SPIE on IRFPAs "Fundamental Studies of Schottky Barrier IR Detectors by Ballistic Electron Emission Microscopy"

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**Contact Name:** Wilson Twohig  
**Position:** Pres  
**Organization:** Timeco Inc  
**Component:**  
**Address:** 1035 26th St.  
Huntington, WV 25705  
**Notes:** Timing controls, photoelectric controls, and load sensors.

**Contact Name:** Y.L. Tyan  
**Position:**  
**Organization:** LTV Aerospace and Defense Company  
**Component:**  
**Address:** Mail Stop PT-88  
Dallas, TX 75265  
**Notes:** Co-authored for 1991 MCT Workshop "Analysis of Excess Carrier Lifetime in p-Type HgCdTe Using a Three-Level Shockley-Read Model"

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**Contact Name:** M.N. Udrea-Spenea  
**Position:**  
**Organization:** Enterprise for Semiconductor Devices  
**Component:**  
**Address:** ROMANIA  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Accurate Method for Neutron Fluence Control Used in Improving Neutron-Transmutation-Doped Silicon Detectors"

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**Contact Name:** Sumio Uematsu  
**Position:** Dr.  
**Organization:** Johns Hopkins Hospital  
**Component:**  
**Address:** Meyer 2-147  
600 N. Wolfe Street  
Baltimore, MD 21205  
**Notes:** Active in infrared biomedical thermography, past President of American Academy of Thermology.

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**Contact Name:** A. Unikovsky  
**Position:**  
**Organization:** Kidron Microelectronics Research Center  
**Component:** Department of Electrical Engineering  
**Address:** Technion-Israel Institute of Technology  
Haifa 32000, ISRAEL  
**Notes:** For 1991 MCT Workshop co-authored "Tunneling and 1/f noise currents in HgCdTe Photodiodes"

**Contact Name:** Malcom Unsworth  
**Position:** Gmgr  
**Organization:** Schlumberger Limited  
**Component:** Statham Transducers  
**Address:** 2230 Statham Rd.  
Oxnard, CA 93033  
**Notes:** Micromachined silicone and thin film sensors.

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**Contact Name:** Frank J. Vallese  
**Position:** General Manager  
**Organization:** Electrophysics  
**Component:**  
**Address:** 373 Route 46 West, Building E  
Fairfield, NJ 07004  
**Notes:** Night Vision, thermal imaging for military applications.  
  
Sells their line of Pyroviewer, phovidicon cameras.

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**Contact Name:** Hervert Van Denend  
**Position:** Pres  
**Organization:** Glenro, Inc.  
**Component:**  
**Address:** 29 McBride Ave.  
Paterson, NJ 07501  
**Notes:** Research into infrared system production, infrared ovens

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**Contact Name:** Will Van Dyke  
**Position:** Manager of Advanced Program Development  
**Organization:** SBRC  
**Component:**  
**Address:** 75 Coromar Drive  
Golcta, CA 93117  
**Notes:**

**Contact Name:** A.D. Van Rheenen  
**Position:**  
**Organization:** Minnesota University  
**Component:** Department of Electrical Engineering  
**Address:** Minneapolis, MN  
**Notes:** Co-authored August 1991 "Quantum Noise in Solid-State Devices in Particular HgCdTe Diodes"

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**Contact Name:** M. van Schilfgaarde  
**Position:**  
**Organization:** SRI International  
**Component:**  
**Address:** Menlo Park, CA 94025  
**Notes:** Author of "Comparison of InTiSb and HgCdTe as Infrared Material" and "Native Defect Equilibria in HgZnTe and HgCdTe Alloys" at 1992 MCT Workshop  
For 1991 Workshop, co-authored "Defect Equilibrium in HgTe"

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**Contact Name:** M. van Schilfgaarde  
**Position:**  
**Organization:** SRI International  
**Component:**  
**Address:** Menlo Park, CA 94025  
**Notes:** Co-authored for 1992 MCT Workshop "Comparison of InTiSb and HgCdTe as Infrared Material"

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**Contact Name:** Victor Vargo  
**Position:** Gmgr  
**Organization:** Qualitec-Technologies, Inc.  
**Component:** Optoelectronics Division  
**Address:** 3400 Hillview Ave.  
Palo Alto, CA 94304  
**Notes:** Development of III-V optoelectronic materials and silicon detectors.

**Contact Name:** V.P. Vavilov  
**Position:**  
**Organization:** Tomsk Polytechnic Institute  
**Component:**  
**Address:** Tomsk, RUSSIA  
**Notes:** Authored for 1991 SPIE meeting on IR Technology "Soviet IR IMagers and Their Applications: Short State of the Art"

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**Contact Name:** Richard Veith  
**Position:** President  
**Organization:** Crystal Technology, Inc.  
**Component:**  
**Address:** 1040 E Meadow Circle  
Palo Alto, CA 94303  
**Notes:** Preparation and characterization of single crystal materials for use in optical, acoustic, magnetic applications; device development using these materials in acousto-optics and surface acoustic waves (SAW).

---

**Contact Name:** Tom Venable  
**Position:** Marketing Manager for IR Detectors  
**Organization:** Cincinatti Electronics  
**Component:**  
**Address:** 7500 Innovation Way  
Mason, OH 45040-9699  
**Notes:** Manufactures and designs IR detectors including single-element, linear and two dimensional arrays, discrete channel amplified, multiplexed, in Ge, MCT, InSb and InAs, 1-12 um. Cincinatti Electronics is owned by Canadian Marconi Company, which is, in turn, owned by the General Electric Company.

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**Contact Name:** Frank Verbeke  
**Position:** President  
**Organization:** Alturdyne  
**Component:**  
**Address:** 8050 Armour  
San Diego, CA 92111  
**Notes:** Infrared systems and equipment for military

**Contact Name:** Horacio R. Verdun  
**Position:**  
**Organization:** FIBERTEK, Inc.  
**Component:**  
**Address:** 510 Herndon Parkway  
Herndon, VA 22070  
**Notes:** Co-authored for 1992 MCT Workshop "Tunnelling Current Probe for Contactless Electrical Performance Measurements of Infrared Focal Plane Detector Arrays." Firm manufactures high average power diode array pumped solid-state lasers, CW, Q-switched and frequency doubled, and highly advanced laser receiver for the military market, and laser crystals with new formulations for evaluation purposes.

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**Contact Name:** Jan Vermeiren  
**Position:** Ms.  
**Organization:** IMEC  
**Component:**  
**Address:** Jaockdreef 75  
B-3001 Leuven, BELGIUM  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Comparative study of SWIR and MWIR Schottky-Barrier Imagers"

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**Contact Name:** Vincent Vidas  
**Position:** CEO  
**Organization:** Semcor Inc  
**Component:**  
**Address:** 815 E Gate Dr.  
Mount Laurel, NJ 08054  
**Notes:** Product-oriented research on the systems engineering and program management in support to the government in aeronautics, military science, missile technology, countermeasures, ordnance and fire control communications, radar, acoustic, optics, INFRARED and ultraviolet detection systems.

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**Contact Name:** C.R. Viswanathan  
**Position:**  
**Organization:** University of California, Los Angeles  
**Component:** Electrical Engineering Department  
**Address:** Los Angeles, CA 90024  
**Notes:** For 1991 MCT Workshop, wrote "Compositional Analysis of HgCdTe Epitaxial Layers Using Secondary Ion Mass Spectrometry"

**Contact Name:** Jeffrey Voelker  
**Position:**  
**Organization:** General Electric Company  
**Component:** Electronics Laboratory  
**Address:** Syracuse, NY  
**Notes:** Authored Jan 92 piece evaluating LPE vs. MBE and MOCVD for radiometry.  
Source on cost differences between two methods.

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**Contact Name:** Randall Voight  
**Position:** CEO  
**Organization:** International Research and Evaluation  
**Component:**  
**Address:** 21098 IRE Control Ctr.  
Eagan, MN 55121  
**Notes:** Product-oriented with emphasis on photovoltaic cells.

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**Contact Name:** H. Vydyanath  
**Position:**  
**Organization:** Aerojet Corp.  
**Component:** Electronic Systems Division  
**Address:** Azusa, CA  
**Notes:** Co-authored for 1992 MCT Workshop "Photo-Induced Excess Low Frequency Noise in HgCdTe Photodiodes"

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**Contact Name:** B.K. Wagner  
**Position:**  
**Organization:** Georgia Institute of Technology  
**Component:**  
**Address:**  
**Notes:** Co-authored for 1991 MCT Workshop "Selected-area Epitaxy on CdTe" and "Gas Source Iodine Doping and Characterization of MBE Grown CdTe"

**Contact Name:** Roger Waldock  
**Position:** Pres.  
**Organization:** MR Semicon, Inc.  
**Component:**  
**Address:** 276 Route 59  
Tall Pines Industrial Park  
Monsey, NY 10952-3407  
**Notes:** Manufacture of CdTe and GaAs for infrared applications.

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**Contact Name:** William Wallace  
**Position:** Pres  
**Organization:** Westmark Systems, Inc  
**Component:** Tracor-GIE  
**Address:** 1652 W 820 North  
Provo, UT 84601  
**Notes:** Development of infrared and far-infrared systems.

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**Contact Name:** L. Walther  
**Position:**  
**Organization:** Dresden University of Technology  
**Component:** Institut für Festkörperelektronik  
**Address:** Dresden, FEDERAL REPUBLIC OF GERMANY  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Pyroelectric Linear Array IR Detectors with CCD Multiplexer"

---

**Contact Name:** M.W. Wang  
**Position:** Dr.  
**Organization:** California Institute of Technology  
**Component:**  
**Address:** 1201 East California Boulevard  
Pasadena, CA 91125  
**Notes:** Reported at the DARPA Program Review on Infrared Focal Plane Array Technology in December, 1992, on "InAs/GaInSb Superlattices: Growth Involving Anion Switching"



**Contact Name:** Peter Wang  
**Position:** CEO  
**Organization:** Fermionics  
**Component:**  
**Address:** 4555 Runway St.  
Simi Valley, CA 93063  
**Notes:** Produces wholesale CdTe and participant in CECOMs night vision advanced research. Sells in both military and commercial markets.

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**Contact Name:** Peter C.C. Wang  
**Position:** Chief Executive  
**Organization:** Fermionics Corp.  
**Component:**  
**Address:** 4555 Runway Street  
Simi Valley, CA 93063  
**Notes:**

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**Contact Name:** Wen Sang Wang  
**Position:**  
**Organization:** Rensselaer Polytechnic Institute  
**Component:**  
**Address:** 110 Eight Street  
Troy, NY 12180  
**Notes:** Co-authored "Improved CdTe Layers on GaAs and Si Substrates, Grown by Atomic Layer Epitaxy" for 1992 MCT Workshop  
  
Co-authored for 1991 Workshop "Low Temperature Epitaxy of HgCd, CdTe, and HgCdTe Using Flow Modulation Techniques."

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**Contact Name:** Y.H. Wang  
**Position:**  
**Organization:** University of Florida  
**Component:** Department of Electrical Engineering  
**Address:** Gainesville, FL 32611  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "A Novel Grating Coupled Step-Bound-to-Miniband Transition InGaAs/GaAs/AlGaAs Multiquantum Well Infrared Photodetector"

**Contact Name:** Raymond Wary  
**Position:** Sls Mgr  
**Organization:** PPM Pure Metals  
**Component:**  
**Address:** 111 Richmond Street, West, Suite 418  
Toronto, Ontario, CANADA M5H 2G4  
**Notes:** Manufacture of germanium for infrared technologies.

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**Contact Name:** John Wasyluk  
**Position:** Director of Research  
**Organization:** AGR International, Inc.  
**Component:**  
**Address:** PO Box 149  
Butler, PA 16003-0149  
**Notes:** Development of optical inspection techniques for process control in glass container manufacturing.

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**Contact Name:** Tomoji Watanabe  
**Position:**  
**Organization:** Hitachi Koki Co.  
**Component:** Mechanical Engineering Laboratory  
**Address:** 502 Kandatsu, Tsuchiura, Ibaraki, 300, JAPAN  
**Notes:** Proposed designs for IR detectors for radiation thermometry of silicon wafers in a diffusion furnace for fabrication of LSI.

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**Contact Name:** Gary J. Weil  
**Position:**  
**Organization:** EnTech Engineering, Inc.  
**Component:**  
**Address:** 111 Marine Lane  
St. Louis, MO 63146-2235  
**Notes:** Active in infrared predictive maintenance. Using joint IR/GPR technique.

**Contact Name:** Christopher S. Welch  
**Position:**  
**Organization:** College of William and Mary  
**Component:** Dept of Physics  
**Address:** Williamsburg, VA 23185  
**Notes:** Leader in infrared non-destructive evaluation.

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**Contact Name:** Gary Well  
**Position:**  
**Organization:** EnTech Engineering, Inc.  
**Component:**  
**Address:** 111 Marine Lane  
St. Louis, MO 63146  
**Notes:** Active in infrared remote sensing, using joint IR/GPR technique.

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**Contact Name:** Song Wen-Zhen  
**Position:**  
**Organization:** Shandong University  
**Component:** Infrared and Remote Sensing Rc.  
**Address:** Jinan, Shandong, CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "The Dependence of Fermi Level of HgCdTe on Impurity Concentration and Temperature"

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**Contact Name:** N. Wercley  
**Position:**  
**Organization:** BDM Inc.  
**Component:**  
**Address:** 4001 North Fairfax Drive  
Arlington, VA 22203  
**Notes:** Authored for 1992 SPIE workshop on IRFPAs "Modeling the Cost and Producibility Impacts of IRFPA Operability"

**Contact Name:** Greg Whaley  
**Position:** Business Manager  
**Organization:** Amorphous Materials Inc.  
**Component:**  
**Address:** 3130 Benton Street  
Garland, TX 75042  
**Notes:** Infrared materials production of CdTe, GaAs, and silicon, mainly for military.

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**Contact Name:** Robert White  
**Position:** VP for Sales  
**Organization:** Galileo Electro-Optics Corp.  
**Component:**  
**Address:** Galilco Park, PO Box 550  
Sturbridge, MA 01566  
**Notes:** Develops fiber-optic and electro-optic components which transmit, intensify or sense light images.

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**Contact Name:** Larry Whited  
**Position:** Pres  
**Organization:** Magna Industries, Inc  
**Component:**  
**Address:** 2201 W 110th St., PO Box 734  
Cleveland, OH 44107  
**Notes:** Produce oriented research in infrared products for gas saving devices.

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**Contact Name:** Warner Whitmer  
**Position:** Pres  
**Organization:** CVS Systems & Services, Inc,  
**Component:** CVD Systems & Services  
**Address:** Penn Centre Plaza  
Quakertown, PA 18951  
**Notes:** Production of solar cells and sensor prototyping.

**Contact Name:** P.S. Wijewarnasuriha  
**Position:**  
**Organization:** EPIR, Ltd.  
**Component:**  
**Address:** Oak Brook, IL 60521  
**Notes:** Co-authored for 1992 MCT Workshop "Influence of CdZnTe (211)B Substrate on Electrical Properties of HgCdTe Grown by MBE"

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**Contact Name:** Ronald Willey  
**Position:** Pres  
**Organization:** Willey Corporation  
**Component:**  
**Address:** PO Box 670  
Melbourne, FL 32902  
**Notes:** R&D of unique and sophisticated infrared reflectance spectrophotometry.

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**Contact Name:** Clifford Williams  
**Position:** Pres  
**Organization:** International Sensor Systems, Inc.  
**Component:**  
**Address:** Industrial Park, PO Box 345  
Aurora, NE 68818  
**Notes:** Research in hybrid thick film technology and optical relays.

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**Contact Name:** Clayton Williams  
**Position:** Pres  
**Organization:** Litton Industries, Inc.  
**Component:** Applied Technology Division  
**Address:** 4747 Hellyer Ave., PO Box 7012  
San Jose, CA 95150-7012  
**Notes:** Electro-optic and acousto-optic systems, predominantly for military.

**Contact Name:** Patricia Williamson  
**Position:** Assistant VP Corp. Comm.  
**Organization:** DRS Photonics Corp  
**Component:**  
**Address:** 270 Motor Parkway  
Hauppauge, NY 11788  
**Notes:** Electro optical systems, night vision, infrared systems and equipment for military applications.

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**Contact Name:** Nick Willick  
**Position:** Senior Manager  
**Organization:** McDonnell Douglas Aerospace  
**Component:**  
**Address:** 1801 E. St. Andrew Place  
Santa Ana, CA 92705  
**Notes:** Night Vision, thermal imaging, c/o systems for military markets.

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**Contact Name:** A.F.W. Willoughby  
**Position:**  
**Organization:** University of Southampton  
**Component:** Engineering Materials  
**Address:** Southampton, SO9 5NH  
UNITED KINGDOM  
**Notes:** Authored "Growth Method, Composition, and Defect Structure Dependence of Mercury Diffusion in CdHgTe" for 1992 MCT Workshop.

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**Contact Name:** Jeanine Wilson  
**Position:** Ms.  
**Organization:** Coors Brewing Company  
**Component:**  
**Address:** Golden, CO 80401  
**Notes:** Proposed technique used by Coors to determine the parameters necessary to improve glass distribution in the bottles used by Coors, and thus achieve reductions in glass weight.

**Contact Name:** Bill Wilson  
**Position:** Pres  
**Organization:** Microwave Technology Incorporated  
**Component:**  
**Address:** 4268 Solar Way  
Fremont, CA 94538  
**Notes:** Research on GaAs and silicon for infrared applications.

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**Contact Name:** Robert Wilson  
**Position:** VP  
**Organization:** Textron Inc  
**Component:** Sensor Systems  
**Address:** 201 Lowell St  
Wilmington, MA 01887  
**Notes:** Sensor systems for target discriminations, detections, and tracking.

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**Contact Name:** Kirk Winchester  
**Position:** Marketing Director  
**Organization:** Janos Technology, Inc.  
**Component:**  
**Address:** HCR #33, Box 25  
Townshend, VT 05353-7702  
**Notes:** Manufacturer of CdTe, GaAs, germanium, silicon, ZnS, and ZnSe for infrared applications.

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**Contact Name:** William P. Winfree  
**Position:**  
**Organization:** NASA, Langley Research Center  
**Component:**  
**Address:** MS-231  
Hampton, VA 23665  
**Notes:** Infrared non-destructive evaluation, aging aircraft skins.

**Contact Name:** Debra Withrow  
**Position:** Advertising Manager  
**Organization:** Recognition Concepts, Inc.  
**Component:**  
**Address:** 5200 Convair Drive  
Carson City, NV 89706  
**Notes:** Infrared systems & equipment, imaging software for military applications.

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**Contact Name:** Norman Witriol  
**Position:**  
**Organization:** Louisiana Tech University  
**Component:**  
**Address:**  
**Notes:** Co-authored 1990 "A Simplified Vision System With Robotic Assembly and Manufacturing Applications"

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**Contact Name:** A.F. Witt  
**Position:**  
**Organization:** MIT  
**Component:**  
**Address:** Cambridge, MA 02139  
**Notes:** Co-authored for 1991 MCT Workshop "Nonlinear Optical Effects in Rotationally Twinned CdTe and CdMnTe Crystals"

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**Contact Name:** Darold C. Wobschall  
**Position:** Dr.  
**Organization:** State Univ of NY at Buffalo  
**Component:** Dept of Elec & Computer Engineering  
**Address:** Bell Hall  
Buffalo, NY 14214  
**Notes:** Active in infrared biomedical thermography. Active in designing a multi-wavelength IR system which overcomes problems of emissivity differences in imaging the body.



**Contact Name:** John Wohlgemuth  
**Position:** Head of R & D  
**Organization:** AMOCO Corporation  
**Component:** Solarex Corp  
**Address:** 1335 Piccard Dr.  
Rockville, MD 20850  
**Notes:** Applied R&D including photovoltaic devices and power systems.

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**Contact Name:** T. Wojtowicz  
**Position:**  
**Organization:** University of Notre Dame  
**Component:** Department of Physics  
**Address:** Notre Dame, IN 46556  
**Notes:** Co-authored for 1991 MCT Workshop "Magnetic Generation of electrons and Holes in Semimetallic HgTe-CdTe Superlattices"

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**Contact Name:** Peter A. Wolff  
**Position:**  
**Organization:** MIT  
**Component:** Electronics Research Lab  
**Address:** 77 Massachussets Avenue  
Cambridge, MA 02139  
**Notes:** Co-authored January 1987 "Infrared Nonlinear Optics"

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**Contact Name:** R. Wollrab  
**Position:**  
**Organization:** AEG  
**Component:**  
**Address:** D-7100 Heilbronn  
GERMANY  
**Notes:** Co-authored for 1991 MCT Workshop "Influence of Resonant Defect States on Subband Structures in HgCdTe"

**Contact Name:** Edward Wood  
**Position:** President  
**Organization:** FJW Optical Systems, Inc  
**Component:**  
**Address:** 629 S Vermont St.  
Palatine, IL 60067  
**Notes:** Electro-optical systems and infrared viewing devices for production industries.  
Manufactures IR viewers, IR thermal imagers, and IR non-contact thermometers.

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**Contact Name:** Richard Wood  
**Position:** Pres  
**Organization:** Optical Radiation Corp.  
**Component:**  
**Address:** 1300 Optical Dr.  
Azusa, CA 91702  
**Notes:** Development of electro-optical systems.

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**Contact Name:** Thomas W. Woody  
**Position:** Manager of Product Engineering & Test Development  
**Organization:** Tektronix, Inc.  
**Component:** CCD Product Group  
**Address:** P.O. Box 500, MS 59-567  
Microelectronics Product Line  
Beaverton, OR 97077  
**Notes:** Oversees high performance CCD development at CCD, and has strong knowledge of entire CCD industry, esp. compared with MCT-based detectors

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**Contact Name:** Ronald Wright  
**Position:** President  
**Organization:** Sequa Corporation  
**Component:** Kollsman Military Systems  
**Address:** 220 Daniel Webster  
Merrimack, NH 03054  
**Notes:** A variety of infrared research using primarily HgCdTe and InSb. Most HgCdTe is reportedly supplied by Sofradir.

**Contact Name:** Harrison Wroton  
**Position:** Pres  
**Organization:** Solar Power Engineering Company  
**Component:**  
**Address:** PO Box 91  
Morrison, CO 80465  
**Notes:** Tracking photovoltaic tracking power systems.

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**Contact Name:** Wen-Jack Wu  
**Position:**  
**Organization:** National Taiwan University  
**Component:** Department of Electrical Engineering  
**Address:** 1, Sec. 4, Roosevelt Road  
Taipei, TAIWAN, 10764, REPUBLIC OF CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "A Novel CID Emulator for InSb Array"

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**Contact Name:** Chao-Wen Wu  
**Position:**  
**Organization:** National Taiwan University  
**Component:** Department of Electrical Engineering  
**Address:** 1, Sec. 4, Roosevelt Road  
Taipei, TAIWAN, 10764, REPUBLIC OF CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "A Novel CID Emulator for InSb Array"

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**Contact Name:** Larry S. Wu  
**Position:**  
**Organization:** University of Florida  
**Component:** Department of Electrical Engineering  
**Address:** Gainesville, FL 32611  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "A Novel Grating Coupled Step-Bound-to-Miniband Transition InGaAs/GaAs/AlGaAs Multiquantum Well Infrared Photodetector"

**Contact Name:** Robert N. Wurzbach  
**Position:**  
**Organization:** Philadelphia Electric Company  
**Component:** Peach Bottom Atomic Power Station  
**Address:** Rd #1 Box 208  
Delat, PA 17314  
**Notes:** Designed infrared predictive maintenance regime and purchased equipment for the Peach Bottom Atomic Power plant.

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**Contact Name:** Hu Xierong  
**Position:**  
**Organization:** Shandong University  
**Component:** Infrared and Remote Sensing  
**Address:** Jinan, Shandong, CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "Study of the Recombination Mechanisms and Carrier Lifetimes in HgCdTe Alloy"

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**Contact Name:** Hu Xierong  
**Position:**  
**Organization:** Shandong University  
**Component:** Infrared and Remote Sensing  
**Address:** Shandong University  
CHINA 250100  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "The Effect of Schockley-Read Recombination on Minority-Carrier Lifetime of HgCdTe"

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**Contact Name:** Yang Xiuzhen  
**Position:**  
**Organization:** Shanghai Institute of Technical Physics  
**Component:** Chinese Academy of Sciences  
**Address:** Shanghai, 20092 CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "HgCdTe Photovoltaic Detectors and Some Related Aspects"

**Contact Name:** Hirofumi Yagi  
**Position:**  
**Organization:** Mitsubishi Electric Corporation  
**Component:** LSI Laboratory  
**Address:** 4-1, Mizujara  
Itami, Hyogo, 664 JAPAN  
**Notes:** Co-authored for 1992 SPIE Workshop on IRFPAs "Improved 512X512 IRCSD with Large Fill Factor and High Saturation Level"

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**Contact Name:** Wenzhong Yang  
**Position:**  
**Organization:** Chongqing Optoelectronics Research Institute  
**Component:**  
**Address:** P.O. Box 1102, YongChuan, CHongqing  
CHINA  
**Notes:** Authored at 1992 SPIE meeting on IRFPAs "LWIR Monolithic HgCdTe Infrared Focal Plane Arrays."

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**Contact Name:** Sheng-Jenn Yang  
**Position:**  
**Organization:** Chung-Shan Institute of Science and Technology  
**Component:**  
**Address:** P.O. Box 90008-8-7, Lung-tan, Tao-Yuan  
REPUBLIC OF CHINA  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "A Novel CID Emulator for InSb Array"

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**Contact Name:** G.L. Yang  
**Position:**  
**Organization:** University of Notre Dame  
**Component:** Department of Physics  
**Address:** Notre Dame, IN 46556  
**Notes:** Co-Authored "Staes Confined in the Barriers of Type-III HgTe/CdTe Superlattices" for 1992 MCT Workshop

**Contact Name:** Li Yanjin  
**Position:**  
**Organization:** Shanghai Institute of Technical Physics  
**Component:** Academia Sinica  
**Address:** Shanghai, China 200083  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "The Effect of Shockley-Read Recombination on Minority Carrier Lifetime of HgCdTe"

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**Contact Name:** Bob Yanka  
**Position:**  
**Organization:** GE Aerospace  
**Component:** Electronics Lab  
**Address:** Building 3, Electronic Park  
Syracuse, NY 13211  
**Notes:** Scientist working on MBE, past work on advanced IRFPA concepts for WRight Patterson AFB April 1987-December 1990. The electronics lab works on gas (gallium arsenide) monolithic microwave technology, infrared arrays, high speed digital electronics gas GaAs monolithic

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**Contact Name:** Wan Yong  
**Position:**  
**Organization:** Shandong University  
**Component:** Infrared and Remote Sensing  
**Address:** Shandong University  
CHINA 250100  
**Notes:** Co-authored for 1992 SPIE meeting on IRFPAs "The Effect of Schockley-Read Recombination on Minority-Carrier Lifetime of HgCdTe"

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**Contact Name:** K.M. Yoo  
**Position:** Dr.  
**Organization:** Graduate Center for the City Univ of NY  
**Component:** Dept of Electrical Engineering and Physics  
**Address:** Institute for Ultrafast Spectroscopy & Lasers, Photonics Appl Lab  
New York, NY 10031  
**Notes:** Active in multi-wavelength biomedical thermography system development

**Contact Name:** Larry Yost  
**Position:** SrVP  
**Organization:** Rockwell International Corporation  
**Component:** Industrial Control Group  
**Address:** 1201 S Second St.  
Milwaukee, WI 53204  
**Notes:** Automation systems and industrial controls, including IR sensors.

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**Contact Name:** P.M. Young  
**Position:**  
**Organization:** Harvard University  
**Component:** Division of Applied Sciences  
**Address:** 20 Oxford Street  
Cambridge, MA 92138  
**Notes:** Co-Authored "Augur Lifetimes in Ideal InGaSb/InAs Superlattices" for 1992 MCT Workshop.

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**Contact Name:** Michael F. Young  
**Position:** President  
**Organization:** Young Design  
**Component:**  
**Address:** 7110 Sea Cliff Road  
McLean, VA 22101  
**Notes:** Infrared systems & equipment

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**Contact Name:** z. Yu  
**Position:**  
**Organization:** North Carolina State University  
**Component:** Department of Physics  
**Address:** Raleigh, NC 27695-8202  
**Notes:** AUthored "Integrated Heterostructure Devices Based on II-VI Compound Semiconductors"

**Contact Name:** Z. Yu  
**Position:**  
**Organization:** University of North Texas  
**Component:** Department of Physics  
**Address:** Denton, TX 76203  
**Notes:** Co-Author of "Heavily Accumulated Surfaces of MCT Detectors: Theory and Experiment" for 1992 MCT Workshop.  
For 1991 Workshop, "Investigation of Mercury Interstitials in MCT alloys Using Resonant Impact-Ionization Spectroscopy"

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**Contact Name:** Sunny Y. Yuen  
**Position:**  
**Organization:** MIT  
**Component:** Electronics Research Lab  
**Address:** 77 Massachusetts Avenue  
Cambridge, MA 02139  
**Notes:** Co-authored January 1987 "Infrared Nonlinear Optics"

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**Contact Name:** Ken Zanio  
**Position:** Mr.  
**Organization:** MOSET Corporation  
**Component:**  
**Address:** El Toro, CA 92630  
**Notes:** Authored for 1992 SPIE Workshop on MCT "HgCdTe on Si for Monolithic Focal Plane Arrays" supported by NRL contract from Dean Scribner

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**Contact Name:** Thomas Zappetti  
**Position:** Pres  
**Organization:** Unitron, Inc  
**Component:**  
**Address:** 170 Wilbur Pl., PO Box 469  
Bohemia NY 11716  
**Notes:** Development of advanced optical systems.



**Contact Name:** Cindy Zeidler  
**Position:** Ms.  
**Organization:** Xedar Corp  
**Component:**  
**Address:** 2500 Central Avenue  
Boulder, CO 80301  
**Notes:** infrared non-destructive evaluation

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**Contact Name:** D. Zenatti  
**Position:** Dr.  
**Organization:** Sofradir  
**Component:**  
**Address:** 43/47 rue Camille Pelletan  
92290 Chatenay-Malabry  
FRANCE  
**Notes:** Research scientist working on SOFRADIR's process for reduction of IRFPA costs, presented paper on analysis criteria selection for IRFPA detector production at 1992 SPIE Orlando meeting.

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**Contact Name:** Francis Ziemba  
**Position:** VP  
**Organization:** Applied Electron Corp.  
**Component:**  
**Address:** 2360 Owen Street  
Santa Clara, CA 95054  
**Notes:** Product-oriented research in the field of radiation detection, both nuclear and optical, including alpha, gamma, x-ray and radon detection, also near IR to visible optical radiation detection.

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**Contact Name:** A. Zigelmann  
**Position:** Mr.  
**Organization:** Soreq Nuclear Research Center  
**Component:**  
**Address:** ISRAEL  
**Notes:** Co-authored for 1991 SPIE meeting on Growth of IR Materials "Anodic Oxides on HgZnTe"

**Contact Name:** Steve Zimmerman  
**Position:** Pres  
**Organization:** KRS Electronics Corporation  
**Component:**  
**Address:** Suite 16, 11649 Chairman Dr.  
Dallas TX, 75243  
**Notes:** Optical electronic sensing of liquids gases and temperatures, interest in developing IR products.

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**Contact Name:** P.D. Zingen  
**Position:** Marketing Coordinator  
**Organization:** Astronautics Corporation of America  
**Component:**  
**Address:** 4115 N. Teutonia  
Milwaukee, WI 53209  
**Notes:** Night vision, robotics, security systems, ASW equipment, infrared systems & equipment, for military

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**Contact Name:** U. Zinnegger  
**Position:** Marketing Manager  
**Organization:** Siemens AG  
**Component:**  
**Address:** SI SM MA  
Landsluter Strasse 26  
8044 Unterschleissheim, GERMANY  
**Notes:** Infrared systems & equipment, night vision for military applications.

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**Contact Name:** David Zish  
**Position:** IR CCD Marketing Director  
**Organization:** David Sarnoff Research Center  
**Component:**  
**Address:** CN5300 Washington Road  
Princeton, NJ 08543-5300  
**Notes:**

**Contact Name:** Nello Zuech  
**Position:**  
**Organization:** Vision Systems, Intl  
**Component:**  
**Address:** 3 Milton Drive  
Yardley, PA 19067  
**Notes:** infrared non-destructive evaluation

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**Contact Name:** M. Zutterman  
**Position:** Mr.  
**Organization:** Sofradir  
**Component:**  
**Address:** 43/47 rue Camille Pelletan  
92290 Chatenay-Malabry  
FRANCE  
**Notes:** Marketing Director for their MCT commercialization projects

Appendix G

Questionnaire Sent to Industry Individuals

1742 Swann Street, NW  
Washington, D.C. 20009

August 14, 1992

Mr./Mrs. First Name, Last Name  
Title  
Company  
Address

Dear Mr./Mrs. Last Name:

I am carrying out a study of potential future applications of sensitive infrared materials in industrial processes and commercial products as a consultant to a US Government R&D organization.

Your company is listed in the 1992 edition of the Directory of American Research and Technology, compiled by the Department of Commerce, and is said to be carrying out research on IR technologies. It would be very helpful for our study if you could complete the attached questionnaire and return it to me in the envelope provided. It should require no more than 30 minutes of your time to answer the questions.

I am asking a structured sample of more than 300 companies like yours to respond. Based on these responses, I will prepare an analysis of the view from industry. In return for your time, I will be delighted to make available to you the aggregate results of the survey. Individual responses are considered confidential, however, and will not be distributed further.

If you would like to discuss this study or the questionnaire prior to completing it, please feel free to call me. I can be reached during the day at 202/785-9041.

It would be most helpful to have your response no later than September 8th, 1992.  
Thanks very much for your cooperation.

Yours truly,

Barry M. Blechman

**Future Applications of Sensitive IR Materials  
in Industrial Processes and Commercial Applications**

Which specific research questions related to IR materials or detectors is your organization now pursuing? What benefits will result from the successful solution of these problems?

(Please turn to back of page)

What types of materials/compounds are you working with for infrared applications?

What do you think are the most promising specific applications of the materials with which you work in industrial processes or in commercial end-products? In what time frame -- 1-2 years, 3-7 years, 8-12 years -- do you think that each of these applications will be feasible on a commercial basis?

What specific industrial or commercial applications of sensitive IR materials, like mercury cadmium telluride and cadmium zinc telluride, do you foresee in 1-2, 3-7, or 8-12 years? If you are doing work on other IR materials, like PtSi, GaAs, Si, etc., please answer for those as well.

(Please turn to back of page)

What are the one, two, or three most difficult technological hurdles that have to be overcome in order to see widespread use of each potential application listed above? In particular, what will have to be accomplished to see significant reductions in cost?

Name of individual completing questionnaire: \_\_\_\_\_

Company: \_\_\_\_\_



Questionnaire Sent To University Individuals

1742 Swann Street, NW  
Washington, D.C. 20009

September 4, 1992

Mr./Mrs. First Name, Last Name  
Title  
University Research Center  
Address

Dear Mr/Mrs. Last Name:

I am carrying out a study of potential future applications of sensitive infrared materials in industrial processes and commercial products as a consultant to a US Government R&D organization.

Your center is listed in the 1993 edition of the Research Centers Directory, compiled by Gale Research, and is said to be carrying out research on photoelectric sensors, IR technologies, or both. It would be very helpful for our study if you could complete the attached questionnaire and return it to me in the envelope provided. It should require no more than 30 minutes of your time to answer the questions.

I am asking a structured sample of more than 60 university- affiliated organizations like yours to respond. Based on these responses, I will prepare an analysis of the view from research institutions. In return for your time, I will be delighted to make available to you the aggregate results of the survey. Individual responses are considered confidential, however, and will not be distributed further.

If you would like to discuss this study or the questionnaire prior to completing it, please feel free to call me. I can be reached during the day at 202/785-9041.

It would be most helpful to have your response no later than September 30th, 1992.  
Thanks very much for your cooperation.

Yours truly,  
Barry M. Blechman

## QUESTIONNAIRE

### Future Applications of Sensitive IR Materials in Industrial Processes and Commercial Applications

Which specific research questions related to IR materials or detectors is your research organization now pursuing? What benefits will result from the successful solution of these problems?

(Please turn to back of page)

What types of materials/compounds are you working with for infrared applications?

What do you think are the most promising specific applications of the materials with which you work in industrial processes or in commercial end-products? In what time frame -- 1-2 years, 3-7 years, 8-12 years -- do you think that each of these applications will be feasible on a commercial basis?

What specific industrial or commercial applications of sensitive IR materials, like mercury cadmium telluride and cadmium zinc telluride, do you foresee in 1-2, 3-7, or 8-12 years? If you are doing work on other IR materials, like PtSi, GaAs, Si, etc., please answer for those as well.

(Please turn to back of page)

What are the one, two, or three most difficult technological hurdles that have to be overcome in order to see widespread use of each potential application listed above? In particular, what will have to be accomplished to see significant reductions in cost?

Name of individual completing questionnaire: \_\_\_\_\_

University Center: \_\_\_\_\_

## Appendix H

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## Appendix M

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